

Contributions to the study of the comparative morphology of teeth and other relevant ichthyodorulites in living supraspecific taxa of Chondrichthyan fishes

Editor: M. STEHMANN

Part B: Batomorphii 4b: Order Rajiformes - Suborder Myliobatoidei - Superfamily Dasyatoidea - Family Dasyatidae - Subfamily Dasyatinae - Genera: *Taeniura*, *Urogymnus*, *Urolophoides* - Subfamily Potamotrygoninae - Genera: *Disceus*, *Plesiotrygon*, and *Potamotrygon* (incl. supraspecific taxa of uncertain status and validity), Family Urolophidae - Genera: *Trygonoptera*, *Urolophus* and *Urotrygon* - Superfamily Myliobatidea - Family: Gymnuridae - Genus: *Aetoplatea*.

by J. HERMAN, M. HOVESTADT-EULER, D.C. HOVESTADT and M. STEHMANN.

Abstract

Part B of this series, comprising the Batomorphii is continued with more taxa of the dasyatoid families Dasyatidae and Urolophidae and the myliobatoid family Gymnuridae (additional material). The tooth morphology of their representatives, as specified in the title is described and illustrated by SEM-photographs. Material of type species *Taeniura lymma* (male and female), *Aetoplatea tentaculata* (adult female), *Urogymnus asperrimus* (male) and *Urolophoides matsubarai* (male) became available subsequently, which is described and illustrated additionally. A differential diagnosis and a final conclusion on the odontology of the supraspecific taxa of the Suborder Myliobatoidei will be presented in the final issue dealing with the Myliobatidae.

Key-words: Elasmobranchii - Batomorphii - Rajiformes - Myliobatoidei - Odontology.

Résumé

L'étude de l'odontologie des Batomorphii à laquelle est consacrée la partie B de cette série se poursuit en ce fascicule par l'examen de la dentition de plusieurs taxons de la Superfamille Dasyatoidea (Dasyatidae et Urolophidae). La morphologie dentaire de leurs représentants est décrite et figurée (clichés MEB). Grâce à l'obtention de matériel complémentaire, la description de la dentition d'espèce types comme *Taeniura lymma* (male et femelle), *Aetoplatea tentacula* (femelle adulte), *Urogymnus asper-*

rimus (male) and *Urolophoides matsubarai* (male) a pu être réalisée, complétant ainsi le fascicule précédent.

Diagnose différentielle et conclusions concernant l'odontologie des taxons supraspécifiques du Sous Ordre des Myliobatoidei seront présentées dans le dernier fascicule traitant des Myliobatidae.

Mots-clés: Elasmobranchii - Batomorphii - Rajiformes - Myliobatoidei - Odontologie.

Kurzfassung

Teil B dieser Serie über die Odontologie der Batomorphii wird mit weiteren Taxa der Überfamilie Dasyatoidea, den Familien Dasyatidae und Urolophidae, fortgesetzt; Die Zahnmorphologie der Vertreter ihrer supraspezifischen Taxa, wie im Titel spezifiziert, wird beschrieben und mit REM-Photos illustriert. Zusätzliches Zahnmaterial bereits früher behandelter Taxa ist nachträglich verfügbar geworden von den Typusarten *Taeniura lymma* (male and female), *Aetoplatea tentaculata* (adult female), *Urogymnus asperrimus* (male) und *Urolophoides matsubarai* (male) und wird hier gleichfalls beschrieben und illustriert. Eine Differentialdiagnose und Schlußfolgerungen zu den Taxa der Unterordnung Myliobatoidei werden mit dem abschließenden Folgeteil zur Familie Myliobatidae vorgestellt.

Schlüsselwörter: Elasmobranchii - Batomorphii - Myliobatoidei - Odontologie- Rajiformes.

Part B: Batomorphii - 4b:Order: Rajiformes - Suborder: Myliobatoidei

General introduction

Part B of this series (HERMAN, HOVESTADT-EULER, HOVESTADT & STEHMANN, 1994, 1995, 1996 and 1997) is continued with the present issue 4b as the second contribution on tooth morphology of supraspecific taxa of the suborder Myliobatoidei.

The large number of supraspecific taxa within the suborder, families and subfamilies of myliobatoids has to be published, due to technical limitations, in four issues of this series. The sequence of publication will not reflect any certain classification or taxonomic ordering but merely depend on availability of study material and progress made in its investigation. The forthcoming last issue will provide for each higher taxonomic category the summarizing discussion, final conclusion, and differential diagnosis.

The supraspecific classification and nomenclature of the myliobatoids is according to NELSON (1994).

This issue deals with three potamotrygonine genera *Disceus*, *Plesiopygon*, and *Potamotrygon* (status and validity of which are partly uncertain) and the genera *Trygonoptera*, *Urolophus* and *Urotrygon* of the family Urolophidae (status and validity of which are partly uncertain). *Disceus* GARMAN, 1877 (type species *Disceus thayeri*) is considered as a synonym of *Paratrygon* and *Trygonoptera* as a synonym of *Urolophus*. Their tooth morphology is, nonetheless, presented here to provide additional arguments for their final status. The previous issue (4a) already treated the genera *Taeniura*, *Aetoplatea*, *Urogymnus* and *Urolophoides*, but the material was incomplete. The lacking materials of the type species *T. lymma* (*Taeniura grabata* was used as substitute for description and illustration), the males of *Urogymnus asperrimus* and *Urolophoides matsubarae*, as well as an adult female of *Aetoplatea tentaculata*, became available and will additionally be described and illustrated in this issue, additionally.

Unlike previous issues of this series, listings of the nominal species cannot always be given due to the lack of recent revisions dealing with the validity of nominal species and genera of the myliobatoids (except for NISHIDA, 1990). Instead, an estimated number of species will be given for the genera concerned.

The authors will not draw any nomenclatorially valid conclusions. Being aware of dealing with one complex of characters only, they will present their odontological results and leave it to following revising authors to incorporate also odontological points of view in a full systematic review with eventual taxonomic and nomenclatorial changes. The full bibliographical reference for each genus, subgenus and species will be given in the descriptive section and not be repeated under literature references.

The vascularization of the teeth will be described and illustrated, along with every description of the tooth

morphology, except for *Aetoplatea*, *Urogymnus* and *Urolophoides*, which have been treated in the previous issue 4a. However, the tooth morphology of *Taeniura lymma* appeared to be extremely different from *Taeniura grabata* and therefore, the vascularization of the latter's teeth is described and illustrated additionally.

Superfamily: Dasyatoidea - Family: Dasyatidae

Subfamily: Dasyatinae

Introduction

The lacking materials of the previous issue (4a), namely a male, female and juvenile of *Taeniura lymma* and males of *Urogymnus asperrimus* and *Urolophoides matsubarae* are described and illustrated below. The description and illustration of their vascularization were given in the previous issue (4a) and will not be repeated here.

Material

The following 5 specimen of 3 genera were examined:

<i>Taeniura lymma</i>	
ZMH 10335	♂ 573 mm TL
ZMH 10335	♀ 468 mm TL
ZMH 7313	♂ 369 mm TL

<i>Urogymnus asperrimus</i>	
MTUF No Data	♂ 895 mm DW

<i>Urolophoides matsubarae</i>	
MTUF 25077	♂ 726 mm DW

Description of the odontological characters

Taeniura lymma (FORSKAL, 1775)
(Plates: 1 to 7; textplates: 1 and 2; textfigure 1)

Trygon lymma FORSKAL, 1775. Descriptiones animalium, avium, amphibiorum, iscium, insectorum, vermium, quae in itinere orientali observavit. Molleri, Hauniae, 1-164.

HETERODONTY

The dentition is gradient monognathic heterodont with lateral and posterior teeth becoming lower and bent toward the commissure.

Sexual heterodonty is documented by a high crown on anterior and antero-lateral teeth in males, versus a transverse keel across the crown in females. Ontogenetic heterodonty is present in male juvenile males, having adult female tooth morphology with low crowns.

A juvenile male and female examined, exhibited latero-posterior and posterior teeth with relatively high crowns and thus male features. For the juvenile male juvenile this could indicate an intermediate stage to a corresponding mature male tooth morphology. However, for the female juvenile this is considered as abnormal, as compared to the low crowns of female tooth morphology.

VASCULARIZATION

Although the external morphology of the teeth shows a holaulacorhizid root type, a pulp cavity is absent in the root area, but the place is filled with osteodentine instead. The vascular tubes of the orthodentine in the crown region radiate from the osteons into crown and root. Inner lateral foramina are absent.

(See textfigure 1).

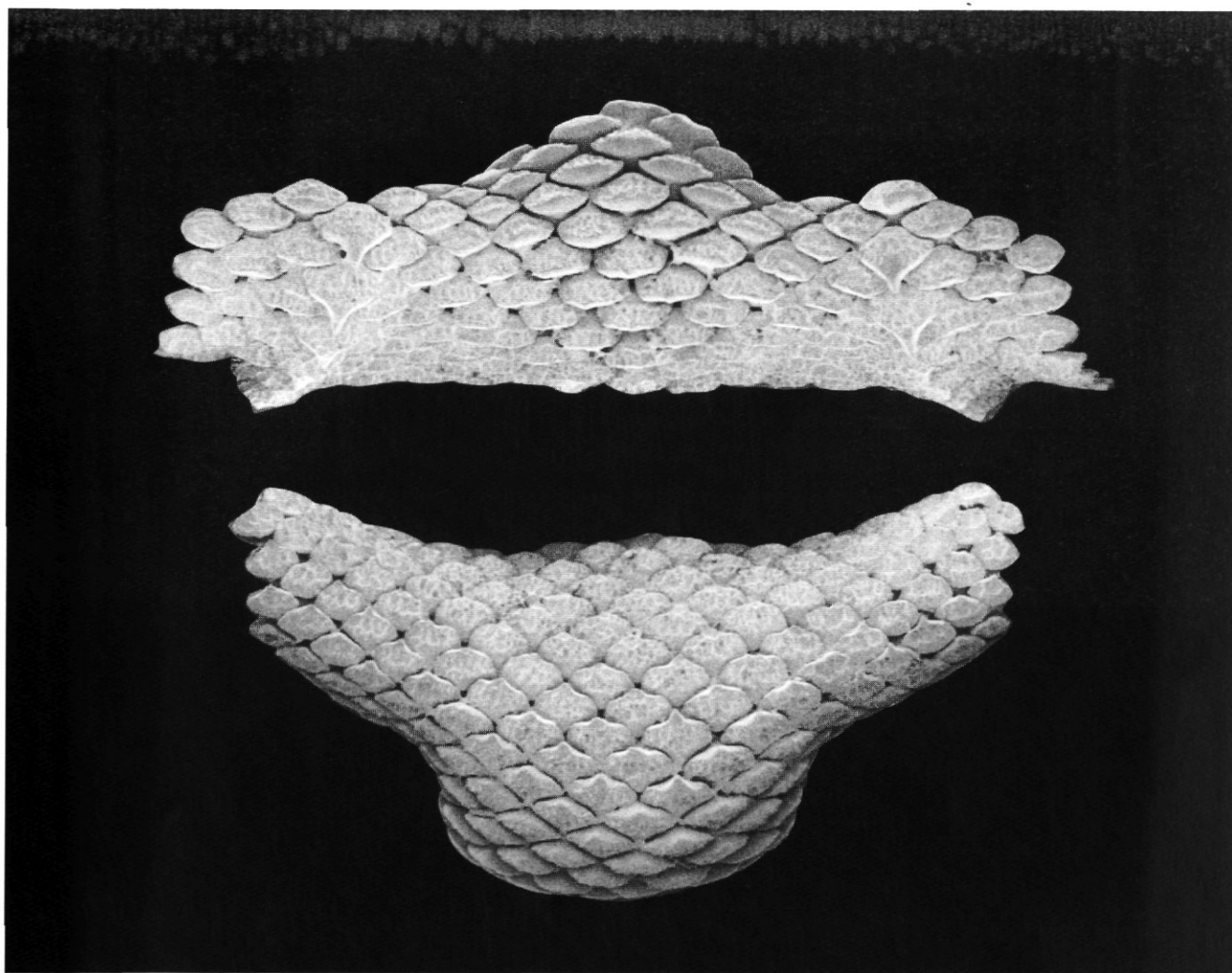


Textfigure 1.

Taeniura lymma tooth histological cross section.

MALES

In occlusal view, the crown has an inward bent high crown with irregularly shaped cutting edges at both sides, which divide the crown into an inner and outer part. The crown is higher than broad in anterior and lateral teeth, slightly bending distally and diminishing in height on lateral and transformed into a transverse keel in posterior teeth. The outer and inner margins of the crown are arched, and both margins join in blunt mesial and distal marginal angles. The inner central ridge at the smooth



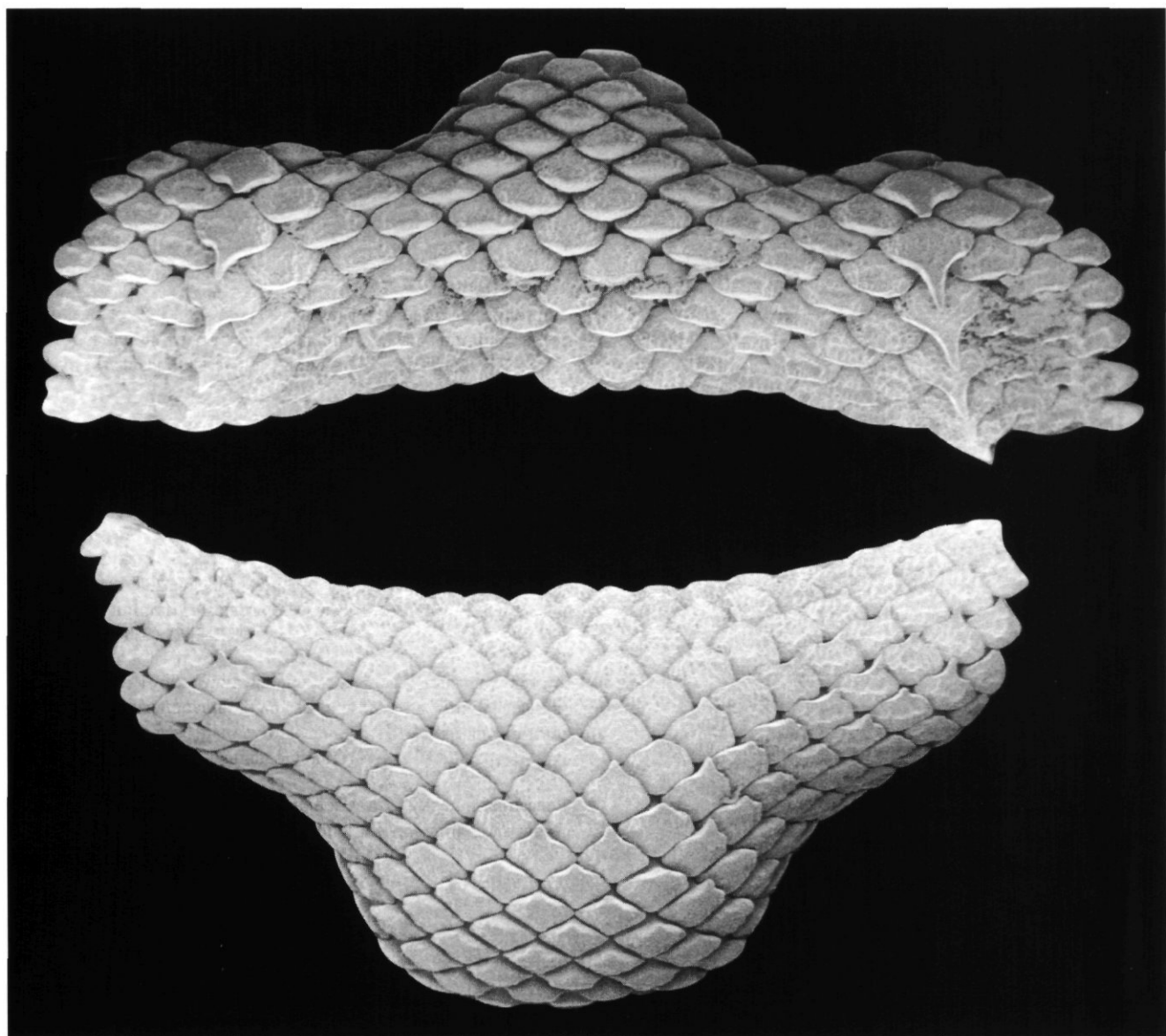
Textplate 1. – *Taeniura lymma* (FORSKAL, 1775). Upper and lower dentition of a female 26.5 cm t.l., Indian Ocean. 12 times enlarged.

inner face is poorly developed. The lower mid-section and the mesial and distal regions are slightly concave and slope toward the rounded inner crown rim. The slightly concave outer part presents coarse, irregularly shaped, more or less reticulated costules in the central area. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the centre of the basal surface of the crown.

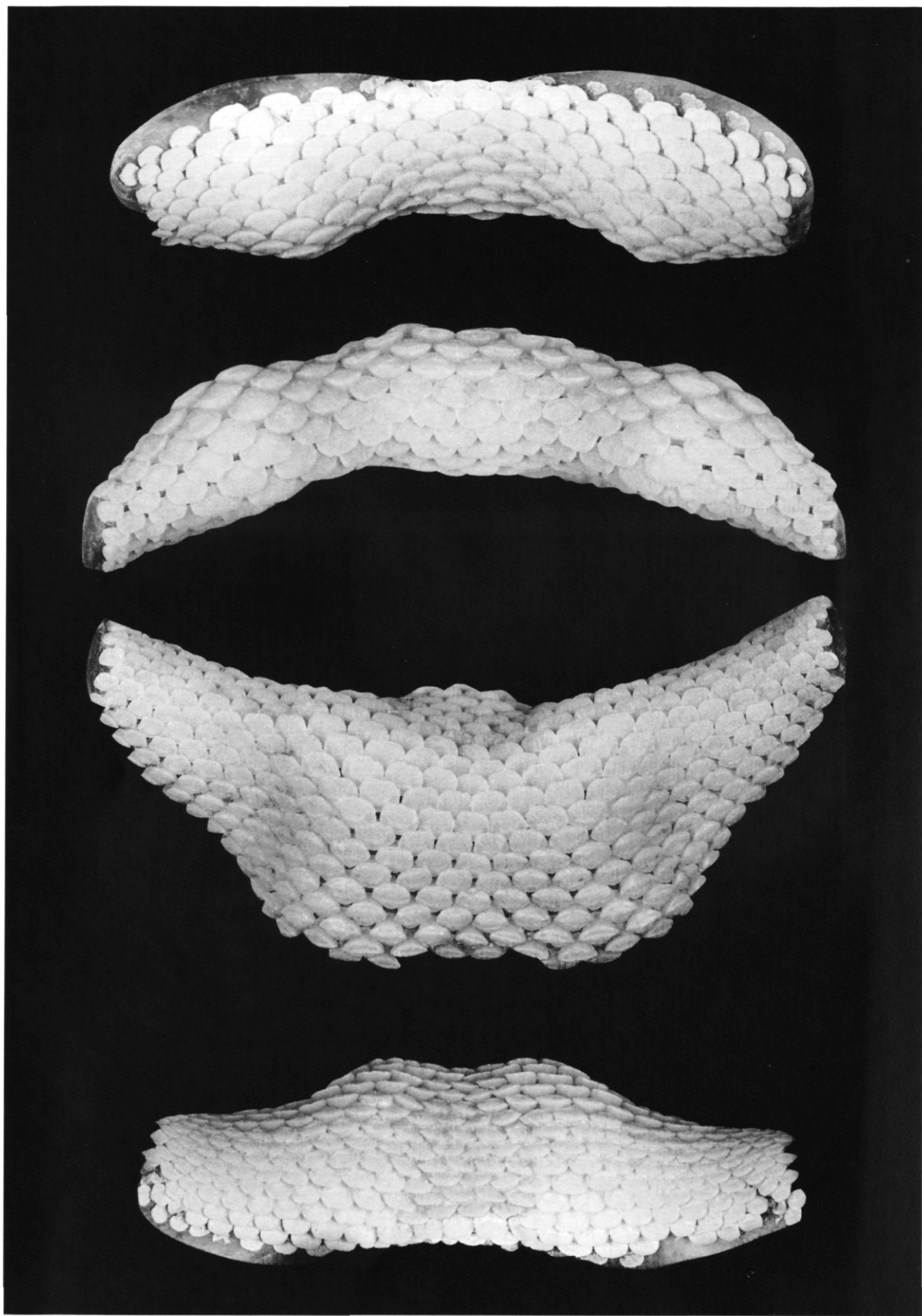
The holaulacorhizid narrow, moderately high root is more or less oval to circular in cross-section, oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep median groove, that encloses one or two central foramina. Inner and outer foramina, as well as root coating are absent.

FEMALES

In occlusal view the crown shows a broad, rounded transverse keel, that is slightly bent inward, dividing the crown into an inner and outer part. The outer margin of the crown is bluntly angled, the inner one is trapezoid shaped, and both margins join in sharp mesial and distal marginal angles. The inner central ridge at the smooth inner face is narrow. The lower mid-section and the mesial and distal regions are slightly concave and slope toward the rounded inner crown rim. The slightly convex outer part presents a well developed reticulated ornamentation, formed by small, deep depressions above the smooth rim, which become slightly wider and shallower close to the transverse keel. The basal view of the crown shows a rather, broad, relatively flat crown rim at the outer part, gradually



Texplate 2. — *Taeniura lymma* (FORSKAL, 1775). Upper and lower dentition of a male 36 cm t.l., Indian Ocean. 12 times enlarged.



Texplate 3. — *Urogymnus asperrimus* (BLOCH & SCHNEIDER, 1801). Upper and lower dentition of a male 89.5 cm t.l., Japan. Circa natural size.

narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the centre of the crown's basal surface.

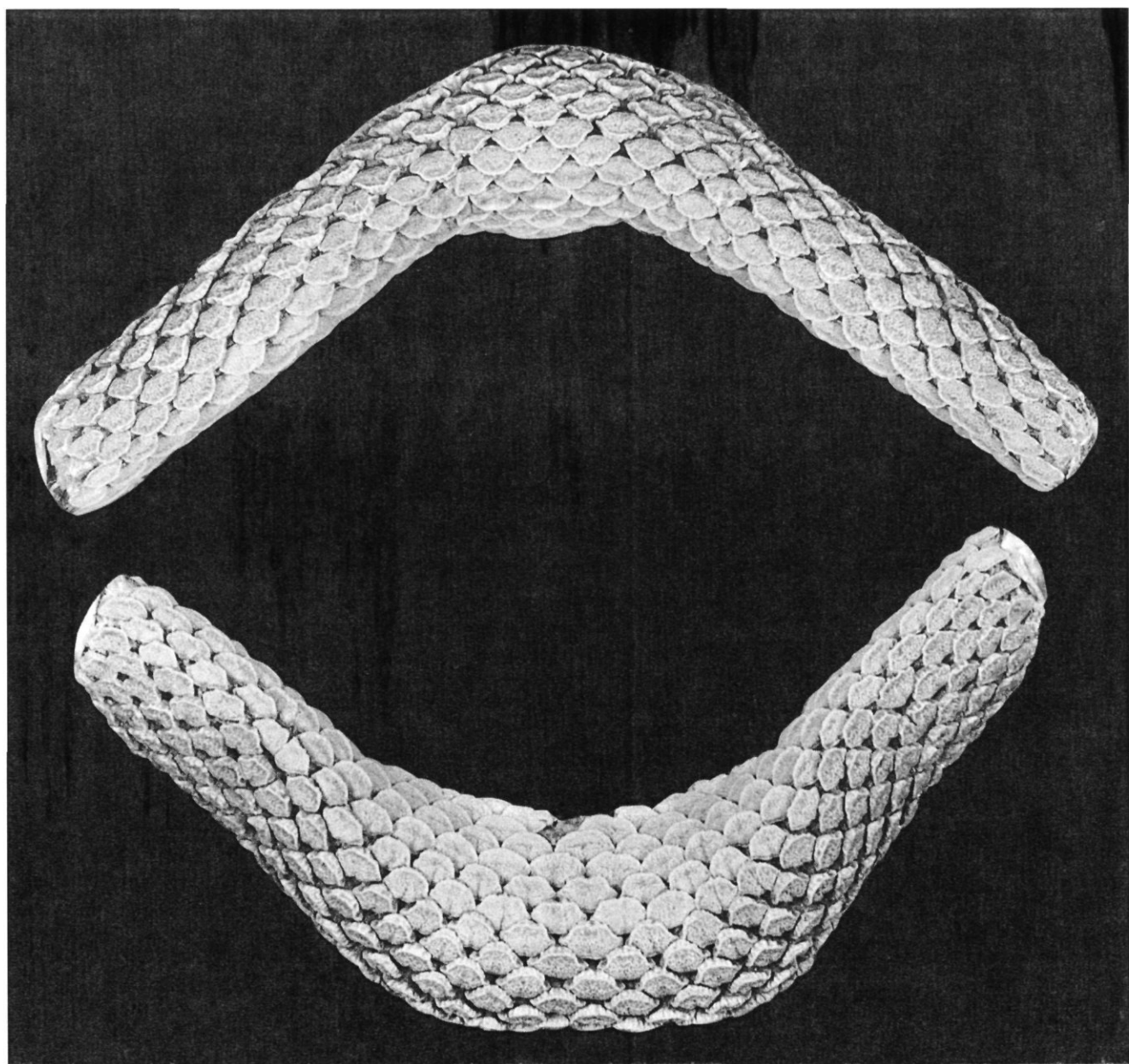
The holaulacorhizid, narrow and moderately high root is more or less oval to circular in cross-section, is oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep median groove, that encloses one or two central foramina. Inner foramina are absent but an outer one may be present above the median groove. Root coating is absent.

Genus: *Urogymnus* MÜLLER & HENLE, 1837

The genus is monotypic with *U. asperrimus*.

Urogymnus asperrimus (BLOCH & SCHNEIDER, 1801)
(Textplate: 3)

Raia asperrima BLOCH & SCHNEIDER, 1801 M.E. Blochii
Systema ichthyologiae iconibus ex illustratum. Post
orbitum auctoris opus inchnatum absolvit, correxuit, inter-
polavit: p. 367



Texplate 4. – *Urolophoides matsubarai* (MIYOSI, 1939). Upper and lower dentition of a male 72.5 cm t.l., Japan. Circa natural size.

HETERODONTY

As presumed in Part B 4a of this series sexual heterodonty does not exist in this taxon.

MALES AND FEMALES

For the description of the female's tooth morphology see Part B 4a. The same tooth morphology features apply to males.

Genus: *Urolophoides* SOLDATOV & LINDBERG, 1930

The genus probably comprises at least three species. Tooth material of the type species *U. giganteus* was not available. *U. matsubarae* was used instead for description and illustration.

Urolophoides matsubarae (MIYOSI, 1939)
(Textplate: 4)

Dasyatis matsubarae Miyosi, 1939. Description of three new species of elasmobranchiate fishes collected at Hyuga Nada, Japan. Bulletin of the Biogeografic Society of Japan 9(5): 91-97

HETERODONTY

As presumed in Part B 4a of this series sexual heterodonty does not exist in this taxon.

MALES AND FEMALES

For the description of the female's tooth morphology see Part B 4a. The same tooth morphology features apply to males.

Subfamily: Potamotrygoninae

Introduction

The subfamily Potamotrygoninae includes after Nelson (1994) the three genera *Paratrygon*, *Plesiotrygon* and *Potamotrygon*. Additionally, the tooth morphology of the genus *Disceus*, junior synonym of *Paratrygon*, will be described and illustrated. Material of *Paratrygon* was not available for examination. Only a juvenile male was available of *Plesiotrygon iwamae*. For the description and illustration of the adult male and female teeth, the original illustrations of ROSA, CASTELLO & THORSON (1987, fig. 6A-K) and teeth of the the paratype ZMH 10343 have been used, respectively.

Material

The following 6 specimen of 4 species were examined for this issue:

Disceus thayeri
IRSNB 17884 ♂ 520 mm TL

Plesiotrygon iwamae
ZMH 10343 (Paratype) ♂ 281 mm DW
ZMH 22404 ♂ 340 mm DW

Potamotrygon histrix
ZMH 10342 ♂ 310 mm DW

Potamotrygon motoro
ISH 17-1989 ♂ 249 mm DW
ISH 17-1989 ♀ 1180 mm 460 mm TL

Description of the odontological characters

Genus: *Disceus* GARMAN, 1877

The genus is monotypic with *D. thayeri*.

Disceus thayeri GARMAN, 1913)
(Plates 8 and 9, textfigure 2)

Disceus thayeri GARMAN, 1913 The Plagiostomia: 426-427.

HETERODONTY

The dentition is gradient monognathic heterodont in that lateral and posterior teeth successively have lower crowns and become smaller.

Sexual heterodonty is probably given by teeth with a low crown in females (Lacking female teeth, this could not be proven). Ontogenetic heterodonty may exist, in that teeth of juvenile males have low crowns.

VASCULARIZATION

Although the external tooth morphology shows a holaulacorhizid root type, a pulp cavity is absent in the root area, but instead there is osteodentine in the same place. The vascular tubes of the orthodentine in the crown region radiate from the osteons into crown and root. Inner lateral foramina are absent.
(See textfigure 2)



Textfigure 2.
Disceus thayeri tooth histological cross section.

MALES

In occlusal view the crown has an inward bent high crown with blunt cutting edges at both sides, which divide the crown into an inner and outer part. The crown is as high as broad and slightly bending distally on lateral and posterior teeth. The outer margin of the crown is arched and sigmoidal sides of the inner one join in a blunt angle, and both margins join in blunt mesial and distal marginal angles. The inner central ridge at the smooth inner face is well developed. The lower mid-section and the mesial and distal regions are concave and slope toward the rounded inner crown rim. The slightly concave outer part is smooth and exhibits several poorly developed, randomly scattered costules. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, gradually narrowing to half its width at the inner part. Both inner and outer crown rims are relatively sharp angled. The crown-root junction lies in a shallow depression in the centre of the crown's basal surface.

The broad and high holaulacorhizid root is more or less oval-shaped in cross-section, is oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep median groove, that encloses a relatively large central foramen. A narrow band of root coating is present at the crown-root junction.

Genus: *Plesiotrygon* ROSA, CASTELLO & THORSON, 1987

The genus is monotypic with *Plesiotrygon iwamae*.

Plesiotrygon iwamae ROSA, CASTELLO & THORSON, 1987
(Plates 10 to 13, textfigure 3)

Plesiotrygon iwamae ROSA, GASTELLO & THORSON, 1987.
Copeia 1987 (2): 447 -458.

HETERODONTY

The dentition is gradient monognathic heterodont with lateral and posterior teeth becoming lower and bent toward the commissure.

Sexual heterodonty is present by a high crown on anterior and antero-lateral teeth in males, versus a transverse keel across the crown in females (ROSA, CASTELLO & THORSON, 1987). Ontogenetic heterodonty is present in juvenile males having adult female tooth morphology with a transverse keel across the crown.



Textfigure 3.

Plesiotrygon iwamae tooth histological cross section.

VASCULARIZATION

Although the external tooth morphology shows a holaulacorhizid root type, a pulp cavity is absent in the root area, but instead there is osteodentine in the same place. The vascular tubes of the orthodentine in the crown region radiate from the osteons into crown and root. Inner lateral foramina are absent.

(See textfigure 3)

MALES

In occlusal view, the crown has an inward bent high crown with cutting edges at both sides, which divide the crown into an inner and outer part. The crown is higher than broad in anterior and lateral teeth, slightly bending distally and diminishing in height on lateral and transformed into a transverse keel in posterior teeth. The outer and inner margins of the crown are arched, and both margins join in blunt mesial and distal marginal angles. The inner central ridge on the smooth inner face is well developed. The lower mid-section and mesial and distal regions are slightly concave and slope toward the rounded inner crown rim. The slightly concave outer part presents poorly developed costules irregularly scattered over its surface. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the centre of the crown's basal surface.

The holaulacorhizid narrow, moderately high root is more or less oval to circular in cross-section, oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep median groove, that encloses one or two central foramina. Inner foramina and root cating are absent.

FEMALES

In occlusal view the crown shows a broadly, rounded transverse keel, that is slightly bent inward, dividing the crown into an inner and outer part. The outer margin of the crown is bluntly angled, the inner one is trapezoid shaped, and both margins join in sharp mesial and distal marginal angles. The inner central ridge at the smooth inner face is narrow. The lower mid-section and the mesial and distal regions are slightly concave and slope toward the rounded inner crown rim. The slightly convex outer part presents poorly developed costules irregularly scattered over its surface. The basal view of the crown shows a rather, broad, relatively flat crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the centre of the crown's basal surface. The holaulacorhizid, narrow and moderately high root is more or less oval to circular in cross-section, oblique toward the rear of the tooth, and slightly diverges at the

root base. The root base presents a well developed, deep median groove, that encloses one or two central foramina. Inner foramina are absent but an outer one may be present above the median groove. Root coating is absent.

Genus: *Potamotrygon* GARMAN, 1877

This genus comprises about 18 species (ROSA, 1985). The type species is *Phistrix*.

Potamotrygon histrix (MÜLLER & HENLE, 1841)
(Plates 14 and 15, textfigure 4)

Taeniura histrix MÜLLER & HENLE, 1841 Systematische Beschreibung der Plagiostomen: p.167.

HETERODONTY

The dentition is gradient monognathic heterodont through teeth with low crown, that diminish in size toward the commissure. Although females were not available for examination, sexual heterodonty is assumed because of the high crown of anterior male teeth, whereas female teeth of related species usually have a low crown.

VASCULARIZATION

The teeth show an adapted, holaulacorhizid root type with a broadly, elongated pulp cavity in the root area, from which the vascular tubes of the circumpulpar dentine radiate into crown and root. Osteodentine was not observed, and inner lateral foramina are absent. (See textfigure 4)

MALES

In occlusal view the crown has an inward bent high principal cusp, which is often flattened by abrasion, in anterior teeth. The cusp lowers very rapidly to almost become a transverse keel in lateral and is even totally transformed into a transverse keel in posterior teeth. It divides the semi- triangular crown of anterior and the semi-oval crowns of lateral and posterior teeth into an inner and outer part. The smooth inner face is concave, presenting a well developed inner central ridge in anterior teeth, which is less developed in lateral and absent in posterior teeth. This central ridge slopes toward the rounded inner crown rim.



Textfigure 4.
Potamotrygon histrix tooth histological cross section.

The outer face is also smooth and slightly convex. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, slightly narrowing at the inner part. The crown-root junction lies in a shallow depression in the centre of the crown's basal surface.

The holaulacorhizid root is more or less oval in cross-section, slightly oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, broad and deep median groove, that encloses a large central foramen. Inner and outer foramina are absent. A small band of root coating is present near the crown-root junction.

Superfamily: Dasyatoidea - Family: Urolophidae

Introduction

The family Urolophidae includes after Nelson (1994) 2 genera *Urolophus* and *Urotrygon*. The tooth morphology of *Trygonoptera testacea* is described and illustrated additionally to provide arguments from the odontological point of view for the decision on the final status of this generic taxon.

Material

The following 14 specimen of 8 species were examined for this issue:

Trygonoptera testacea

IRSNB 1219	♂	320 mm	TL
AMS 36227-001	♀	500 mm	TL

Urolophus asterias

ZMH 10368	♂	333 mm	TL
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Urolophus cruciatus

ZMH 10370	♂	334 mm	TL
ZMH 10369	♂	221 mm	TL
ZMH 10370	♀	379 mm	TL

Urolophus expansus

ISH 67-1992	♂	330 mm	TL
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Urolophus jamaicensis

ISH 69-184	♂	167 mm	TL
ISH 69-184	♂	277 mm	TL

Urolophus restaceus

ZMH 10379	♀	493 mm	TL
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Urolophus torpedineus

ZMH 10372	♂	411 mm	TL
ZMH 10372	♂	183 mm	TL
ZMH 10372	♀	226 mm	TL

Urotrygon mundus

Coll.Herman	♀	240 mm	TL
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Description of the odontological characters

Genus: *Trygonoptera* MÜLLER & HENLE, 1838

The genus is monotypic with *T. testacea*.

Trygonoptera testacea (GÜNTHER, 1870)
(Plates 16 to 18, textfigure 5)

Urolophus (Trygonoptera) testacea GÜNTHER, 1870.
Catalogue of fishes of the British Museum 8: p.486.

HETERODONTY

The dentition is gradient monognathic heterodont in that lateral teeth are slightly broader than anterior ones, and become narrower toward the commissure.

Lacking a male, sexual heterodonty could not be determined.

VASCULARIZATION

The teeth show an adapted, holaulacorhizid root type with a broad pulp cavity in the root area, from which the vascular tubes of the circumpulpar dentine radiate into crown and root. Osteodentine was not observed, and inner lateral foramina are absent.

(See textfigure 5)

FEMALES

In occlusal view, the crown has a low transversal keel, dividing the crown into an inner and outer part. The outer margin of the crown is arched and the inner one more or less roundish to trapezoid, and both margins join in mesial and distal marginal angles. The inner central ridge at the smooth inner face is poorly developed or mostly even hardly perceptible. The lower mid-section and the mesial and distal regions are slightly concave and slope toward the rounded inner crown rim. The slightly concave outer part is also smooth at the lower region, but may present some poorly developed, irregular costules in the midsection on anterior teeth. The basal view of the crown shows a rather broad, slightly convex crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the centre of the crown's basal surface.

The holaulacorhizid root is more or less oval in cross-section, is oblique toward the rear of the tooth, and slightly



Textfigure 5.

Trygonoptera testacea tooth histological cross section.

diverges at the root base. The root base presents a well developed, deep median groove, that encloses one or two central foramina with sometimes one or two smaller additional ones at its outer part. Inner foramina are absent and root coating are absent.

Genus: *Urolophus* MÜLLER & HENLE, 1837

The genus comprises seven species. Type species is *U. cruciatus*,

Urolophus cruciatus (LACEPEDE, 1804)
(Plates 19 to 23, textfigure 6)

Raia cruciatus LACEPEDE, 1804 Sur plusieurs animaux de la Nouvelle Hollande. Annales du Museum d'histoire naturelle, Paris 4: 184-211

HETERODONTY

The dentition is gradient monognathic heterodont in that lateral teeth slightly are broader than the lateral ones and become narrower toward the commissure.

Sexual heterodonty is documented by a high, pointed crown in males contrasting a flat crown in females. Ontogenetic heterodonty is present, in that juvenile males have a low crown, and the outer ornamentation of the crown is poorly developed.

VASCULARIZATION

The teeth show an adapted, holaulacorhizid root type with a broad pulp cavity in the root area, from which the vascular tubes of the circumpulpar dentine radiate into crown and root. Osteodentine was not observed, and inner lateral foramina are absent.

(See textfigure 6)

MALES

In occlusal view the crown has an inward bent relatively high crown with cutting edges at both sides, which divide the crown into an inner and outer part. The crown is as high as broad and slightly bent distally on lateral and posterior teeth. The outer margin of the crown is arched and the inner one more or less roundish to trapezoid, and both margins join in mesial and distal marginal angles.



Textfigure 6.

Urolophus cruciatus tooth histological cross section.

The inner central ridge at the smooth inner face is poorly developed. The lower mid-section and the mesial and distal regions are slightly concave and slope toward the rounded inner crown rim. The slightly concave outer part exhibits a coarse reticulated ornamentation, with deep depressions at the base and becoming less deep toward the apex. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the centre of the crown's basal surface.

The holaulacorhizid root is more or less oval in cross-section, is oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep median groove, that encloses one central foramen. Inner and outer foramina are absent and root coating are absent.

FEMALES

In occlusal view, the crown has low transverse keel, which divides the crown into an inner and outer part. The outer margin of the crown is arched and the inner one more or less roundish to trapezoid, and both margins join in mesial and distal marginal angles. The inner central ridge at the smooth inner face is poorly developed. The lower mid-section and the mesial and distal regions are slightly concave and slope toward the rounded inner crown rim. The slightly concave outer part exhibits a coarse reticulated ornamentation, with deep depressions. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the center of the crown's basal surface.

The holaulacorhizid root is more or less oval in cross-section, is oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep median groove, that encloses a central foramen. Inner and outer foramina and root coating are absent.

Genus: *Urotrygon* GILL, 1863

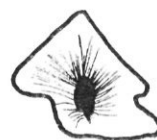
The genus comprises about 4 species. The type species is *Urotrygon mundus*.

Urotrygon mundus GILL, 1863
(Plates 24 and 25, textfigure 7)

Urotrygon mundus GILL, 1863 Proceedings of the Academie of Natural Science, Philadelphia: p.173.

HETERODONTY

The dentition is gradient monognathic heterodont with low crowns on mesial-distally broad teeth, diminishing in size



Textfigure 7.
Urotrygon mundus tooth histological cross section.

toward the commissure. Sexual heterodonty could not be determined, lacking a male specimen, but is not expected. Also ontogenetic heterodonty is supposed to be absent.

VASCULARIZATION

The teeth show an adapted, holaulacorhizid root type with a broad pulp cavity in the root area, from which the vascular tubes of the circumpulpar dentine radiate into crown and root. Osteodentine was not observed, and inner lateral foramina are absent

(See textfigure 7)

FEMALES

In occlusal view, the crown has a slightly, inwardly bent, low transverse keel, which is often flattened by abrasion. It divides the crown into an inner and outer part. Both inner and outer margins are arched. The smooth inner face is slightly concave, lacks an inner central ridge and slopes toward the rounded inner crown rim. The likewise smooth outer face is convex. Inner and outer ornamentation is absent. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the centre of the crown's basal surface.

The broad holaulacorhizid root is more or less oval in cross-section, slightly oblique toward the rear of the tooth, and slightly diverges toward the root base. The root base presents a well developed, deep median groove, enclosing a large aperture. Inner and outer foramina and root coating are absent.

Superfamily: Myliobatoidea - Family: Gymnuridae

Introduction

For the investigation of dasyatoid material of the previous issue (4a), adult male and female specimens of *Aetoplatea tentaculata* were lacking. However an adult female became available and their teeth are described and illustrated below.

Material

The following specimen was examined:

Aetoplatea tentaculata

BMNH 1909.1.12.28

♀ 608 mm DW

Description of the odontological characters

Genus: *Aetoplatea* MÜLLER & HENLE, 1839

This genus comprises after NELSON (1994) two species. The type species is *A.tentaculata*.

Aetoplatea tentaculata VALENCIENNES, 1839
(Plate 26)

Aetoplatea tentaculata VALENCIENNES, 1839 In: Systematische Beschreibung der Plagiostomen, MÜLLER & HENLE (1841): p.175.

HETERODONTY

The dentition is gradient monognathic heterodont through teeth slightly narrowing teeth toward the commissure. Lacking male reference material, sexual heterodonty could not be determined but is almost certainly absent. Ontogenetic heterodonty is present by slightly broader teeth in juveniles.

FEMALES AND MALES

The crown base has a concavely arched outer margin and a convexly arched inner margin in occlusal view. Inner and outer faces are divided by mesial and distal cutting edges, which are bending from their origin to run almost horizontally over half their length and suddenly rise upward to terminate at the apex. The crown is as broad as high. Apron and ornamentation on the crown, as well as inner and outer ornamentation are absent. The inner surface is convex at the mid-section and concave at mesial and distal regions. The outer surface is strongly concave. The outer part of the crown overhangs the root and exhibits lappet-shaped mesial and distal extensions at the base, that are strongly bent outward. The outer crown base is slightly arched.

The holaulacorhizid root is short and broad, with a likewise broad, moderately deep median groove at the basal face, that encloses a central aperture. Inner foramina are absent, but one or two outer foramina may be present below the crown-root junction, at both sides or above the median groove. Root coating is present in the upper region near the crown-root junction on inner and outer faces.

Acknowledgements:

The authors thank Prof.Dr.H.Wilkens, Zoologisches Institut und Zoologisches Museum der Universität Hamburg (ZMH); Dr.H.Ishihara, Suido-sha Concrete Co. Ltd, Biol. Dept., Kawasaki, Japan; Mr.O.Asakawa, Museum of the Tokyo University of Fisheries (MTUF); Mr.K.Homma, Kyowa Concrete Industry Co., Japan, Dr.D.Nolf, Institut Royal des Sciences naturelles de Belgique, Brussels, Dr.P.Last, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Hobart, Australia and Mr.N.Merrett, The Natural History Museum, London (BMNH) for permission to examine specimens at their disposal. We also would like to thank Mrs.G.Schulze (ZMH) and Mr.O.Crimmen (BMNH) for technical assistance during study visits to these collections. The SEM-photographs were taken by J.Cillis, Institut Royal des Sciences naturelles de Belgique, Brussels.

Bibliography:

- HERMAN, J., HOVESTADT-EULER, M., HOVESTADT, D. & STEHMANN, M., 1994. Part B Batomorphii No. 1a: Order Rajiformes - Suborder: Rajoidei - Family: Rajidae Genera and Subgenera: *Anacanthobatis* (*Schroederobatis*), *Anacanthobatis* (*Springeria*), *Breviraja*, *Dactylobatus*, *Gurgesiella* (*Gurgesiella*), *Gurgesiella* (*Fenestrata*), *Malacoraja*, *Neoraja* and *Pavoraja*. Stehmann, M. (Ed.) Contributions to the study of the comparative morphology of teeth and other relevant ichthyodorulites in living suprageneric taxa of Chondrichthyan fishes. *Bulletin de l'Institut Royal des Sciences naturelles de Belgique, Biologie*, 64: 165-207.
- HERMAN, J., HOVESTADT-EULER, M., HOVESTADT, D. & STEHMANN, M., 1995. Part B Batomorphii No. 1a: Order Rajiformes - Suborder: Rajoidei - Family: Rajidae Genera and Subgenera: *Bathyraja* (with deep-water, shallow water and transitional morphotypes), *Psammobatis*, *Raja* (*Amblyraja*), *Raja* (*Dipturus*), *Raja* (*Leucoraja*), *Raja* (*Raja*), *Raja* (*Rajella*) (with two morphotypes), *Raja* (*Rioraja*), *Raja* (*Rostroraja*), *Raja lineata* and *Sympterygia*. Stehmann, M. (Ed.) Contributions to the study of the comparative morphology of teeth and other relevant ichthyodorulites in living suprageneric taxa of Chondrichthyan fishes. *Bulletin de l'Institut Royal des Sciences naturelles de Belgique, Biologie*, 65: 237-307.
- HERMAN, J., HOVESTADT-EULER, M., HOVESTADT, D. & STEHMANN, M., 1996. Part B Batomorphii No. 1a: Order Rajiformes - Suborder: Rajoidei - Family: Rajidae Genera and Subgenera: *Arhynchobatis*, *Bathyraja richardsoni*-type *Cruriraja*, *Irolita*, *Notoraja*, *Pavoraja* (*Insentiraja*), *Pavoraja* (*Pavoraja*), *Raja* (*Atlantoraja*), *Raja* (*Okamejei*) and *Rhinoraja*. Stehmann, M. (Ed.) Contributions to the study of the comparative morphology of teeth and other relevant ichthyodorulites in living supraspecific taxa of Chondrichthyan fishes. *Bulletin de l'Institut Royal des Sciences naturelles de Belgique, Biologie*, 66: 179-236.
- HERMAN, J., HOVESTADT-EULER, M., HOVESTADT, D. & STEHMANN, M., 1997. Part B Batomorphii No. 2: Order Rajiformes - Suborder Pristoidei - Family: Pristidae - Genera: *Anoxypristis* and *Pristis* No. 3: Suborder Rajoidei - Superfamily Rhinobatoidea - Families: Rhinidae - Genera: *Rhina* and *Rhynchonatus* and *Rhinonotidae* - Genera: *Aptychotrema*, *Platyrhina*, *Platyrhinoides*, *Rhinobatos*, *Trygonorrhina*, *Zanobatus* and *Zapteryx*. Stehmann,

M. (Ed.) Contributions to the study of the comparative morphology of teeth and other relevant ichthyodorulites in living supraspecific taxa of Chondrichthyan fishes. *Bulletin de l'Institut Royal des Sciences naturelles de Belgique, Biologie*, 67: 107-162.

HERMAN, J., HOVESTADT-EULER, M., HOVESTADT, D. & STEHMANN, M., 1998. Part B Batomorphii No. 4a: Order Rajiformes - Suborder Myliobatoidei - Superorder Dasyatioidea - Family: Dasyatidae - Subfamily Dasyatinae - Genera: *Amphotistius*, *Dasyatis*, *Himantura*, *Pastinachus*, *Pteroplatytrygon*, *Taeniura*, *Urogymnus* and *Urolophoides* incl. supraspecific taxa of uncertain taxa and validity), Superfamily Myliobatoidei - Family Gymnuridae - Genera: *Aetoplatea* and *Gymnura*, Superfamily Plesiobatoidei - Family Hexatrygonidae - Genus: *Hexatrygon*. Stehmann, M. (Ed.) Contributions to the study of the comparative morphology of teeth and other relevant ichthyodorulites in living supraspecific taxa of Chondrichthyan fishes. *Bulletin de l'Institut Royal des Sciences naturelles de Belgique, Biologie*, 68: 145-197.

NELSON, J.S. - 1994. Fishes of the World (3rd ed.). John Wiley & Sons, Inc. New York. VII + 600 pp.

ROSA, R.S., CASTELLO, H.P. & THORSON, T.B. - 1987. *Plesiostyrion iwamae*, a new genus and species of neotropical freshwater stingray (Chondrichthyes: Potamotrygonidae). *Copeia*, 1987: 447-458.

General glossary

(applying to all previous issues of this series).

CONCERNING THE JAW

Anterior

Tooth position close to junction of left and right jaw halves.

Commissural

Tooth position near the end of jaw.

Dignathic

Heterodont by having different tooth morphology in upper and lower jaws.

File

Tooth row from symphysis toward end of jaw.

Heterodonty

Different tooth morphology within a tooth file. There are two types of heterodonty: dignathic and monognathic.

Homodonty

Uniform tooth morphology within a tooth file

Lateral

Tooth positions half way along the jaw.

Longitudinal

Symphysial/commissural direction of a tooth file.

Monognathic

Heterodonty within one jaw only. (this can appear as gradient or disjunct)

Parasymphysial

First anterior tooth row, if a symphysial tooth row is absent.

Posterior

Tooth positions toward the angle of jaws.

Pseudosymphysial

One of the parasymphysial tooth rows placed in the position of the symphysial tooth row (symmetry).

Row

Tooth row from inner face to outer face of jaw.

Symphysial

Teeth at junction of both halves of a jaw.

Transverse

Outer/inner direction of a row.

CONCERNING THE TOOTH

An-,Hemi-,Hol- and Polyaulacorhizid

Concerning their vascularization, E.Casier(1947) recognized and described four phylogenetically significant root types within the orthodont histotypes of elasmobranch teeth.

Anaulacorhizid

Vascularization through scattered foramina of equal size on both outer and inner faces, (e.g. Hexanchidae).

Hemiaulacorhizid

Vascularization through a median groove and 1 or 2 lateral foramina on inner face, (like in Squatinidae and Orectolobidae)

Holaulacorhizid

Vascularization through many small foramina concentrated in a median groove"running from outer to inner face, (e.g. Rajidae)

Polyaulacorhizid

Vascularization through many small foramina concentrated in several grooves running parallel from outer to inner face, (e.g. Myliobatidae)

Apron

Expansion of the central part of the outer crown base.

Basal

Bottom face concerned.

Inner central ridge

Convex protrusion at the upper midsection of the inner crown face.

Costules

Short, vertical ridges sometimes present on inner and/or outer crown base.

Crown

Enamelated tooth part.

Distal

Tooth edge or part toward angle of jaws.

Histotype

Type of internal tooth vascularization.

Inner face

Viewed from inside the mouth.

Longitudinally

Apico-basally directed structuring on a tooth.

Median groove

Groove running from the inner root base to the inner crown-root junction, dividing a holaulacorhizid type of root into two root lobes. It includes the main foramina of the vascularization system.

Mesial

Tooth edge or part toward junction (symphysis) of left and right jaw halves.

Neo-holaulacorhizy

Modification of the holaulacorhizid type of root, combining a shallow median groove and an extremely expanded pulp cavity.

Orthodont

Histotype of vascularization, by which a tooth is supplied primarily by an internal pulp cavity radiating into numerous tiny canals penetrating the orthodentine layer.

Osteodont

Histotype of vascularization, by which a tooth is supplied without any pulp cavity by scattered tiny cavities and canals penetrating the osteodentine layer of the root and the internal crown material.

Outer face

Viewed from outside the mouth.

Pseudo-apron

Apron-like vertical ridges that appear sometimes on lateral and posterior teeth.

Pseudo-osteodont

The former pulp cavity of an originally orthodont histotype of tooth being filled secondarily with osteodentine.

Pulp cavity

Cavity inside the tooth from which the vascularization is spread via canaliculi.

Root

Non-enamelled tooth part, that forms the junction with the jaw gum and provides vascularization of the tooth.

Root coating

Coating on the upper part of the root (probably enameliod)

Root stem

Root part between the crown base and root lobe section.

Secondary anaulacorhizid

Median groove of a holaulacorhizid type of root totally overgrown to form a closed tube internally connected or merged with the pulp cavity

Secondarily hemiaulacorhizid

Median groove of holaulacorhizid type of root overgrown to various extent, converting the median groove to an internal tube, which is merged with the pulp cavity.

Striae

Vertical ridges running from crown base toward apex.

Sulcus

Groove developed by the primary vascularization canals leading from root base to the main foramina in anaulacorhizid root type. It differs from the median groove in which several foramina are concentrated of the holaulacorhizid root type and the parallel grooves of the polyaulacorhizid root type, respectively, in that a sulcus lacks foramina.

Transverse

Mesio-distally directed.

Transverse keel

Transverse ridge dividing the crown into inner and outer face.

Uvula

Lobate extension of the inner crown base.

Composition of the plates

As far as possible plates of isolated teeth of one juvenile (male or female) and of both male and female adults are presented for each supraspecific taxon.

The plates have a consistent composition: upper teeth are presented with their cusps downward and lower teeth with their cusps upward.

The choice of left or right jaw halves illustrated depends on the preservation quality of the specimen's tooth files only.

Legend:

a = anterior position

la = latero-anterior

l = lateral position

lp = Latero-posterior

p = posterior position

c = commissural position

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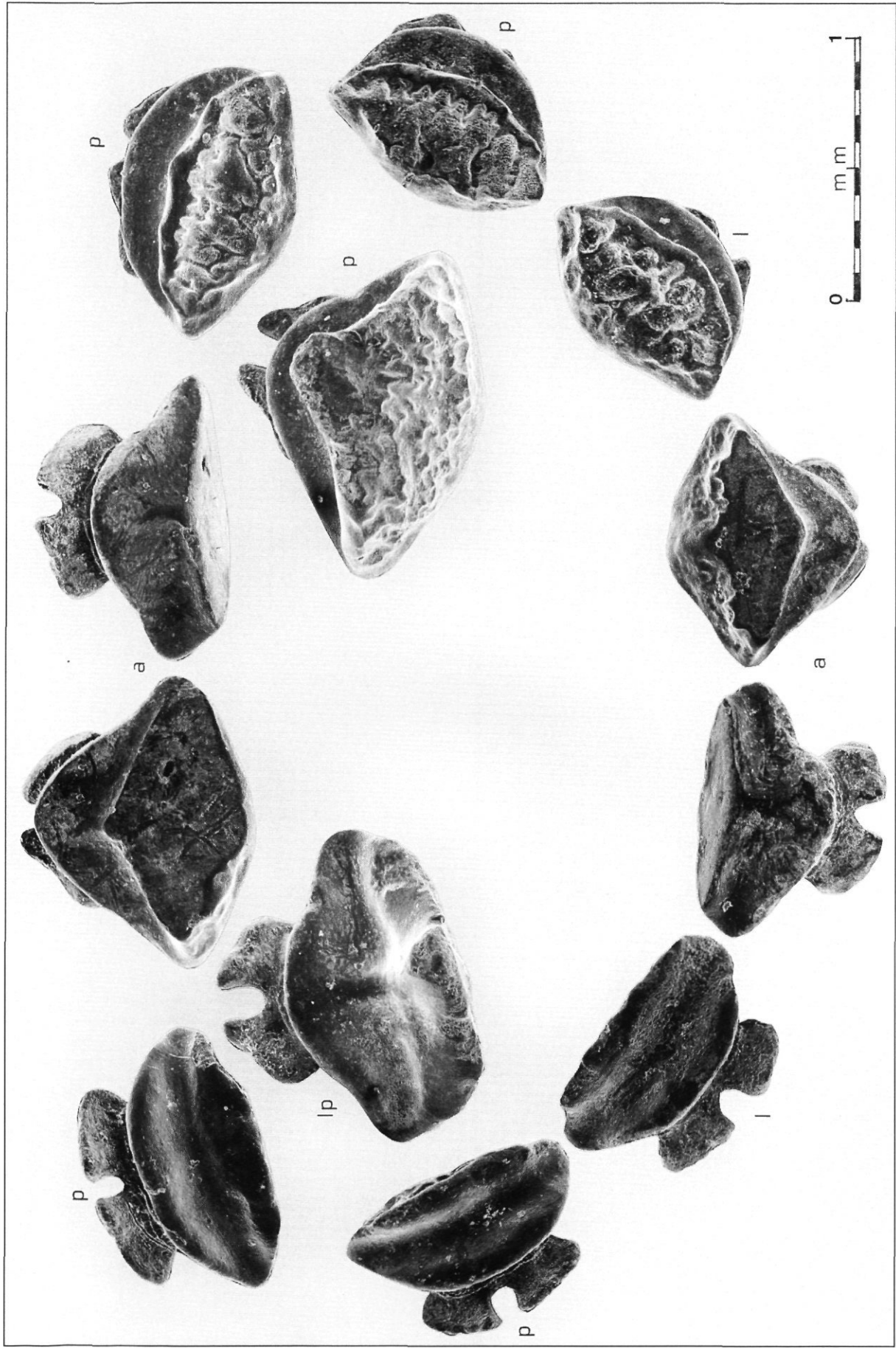


Plate 1. — *Taeniura lymma* (FORSKAL, 1775). Male 37 cm t.l., Aquarium of the Zoo of Berlin. Upper and lower teeth.

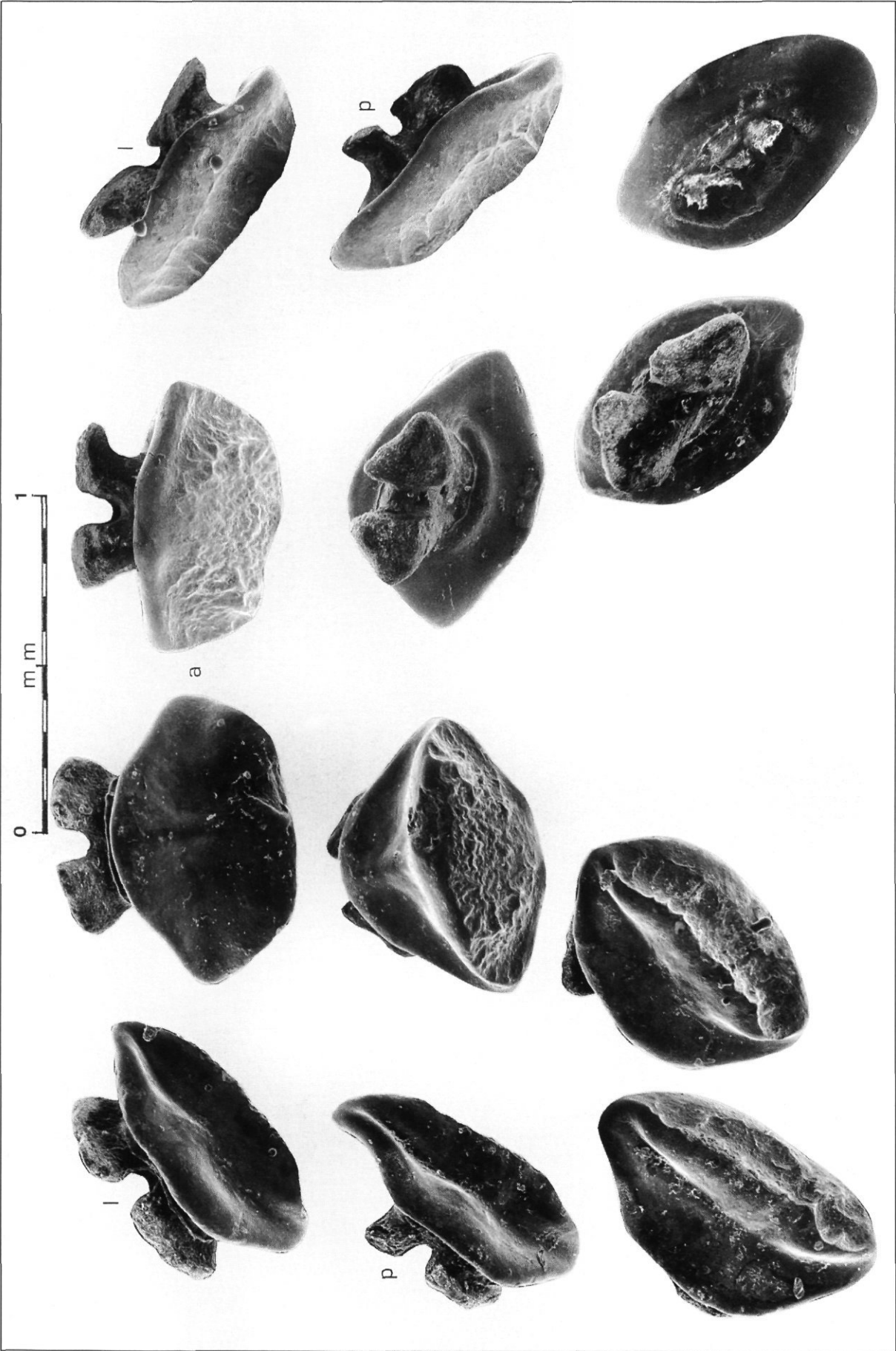


Plate 2. – *Taeniura lymma* (FORSKAL, 1775). Female 47 cm t.l., off Madagascar. Upper teeth.



Plate 3. - *Taeniura lymma* (FORSKAL, 1775). Female 47 cm t.l., off Madagascar. Lower teeth.

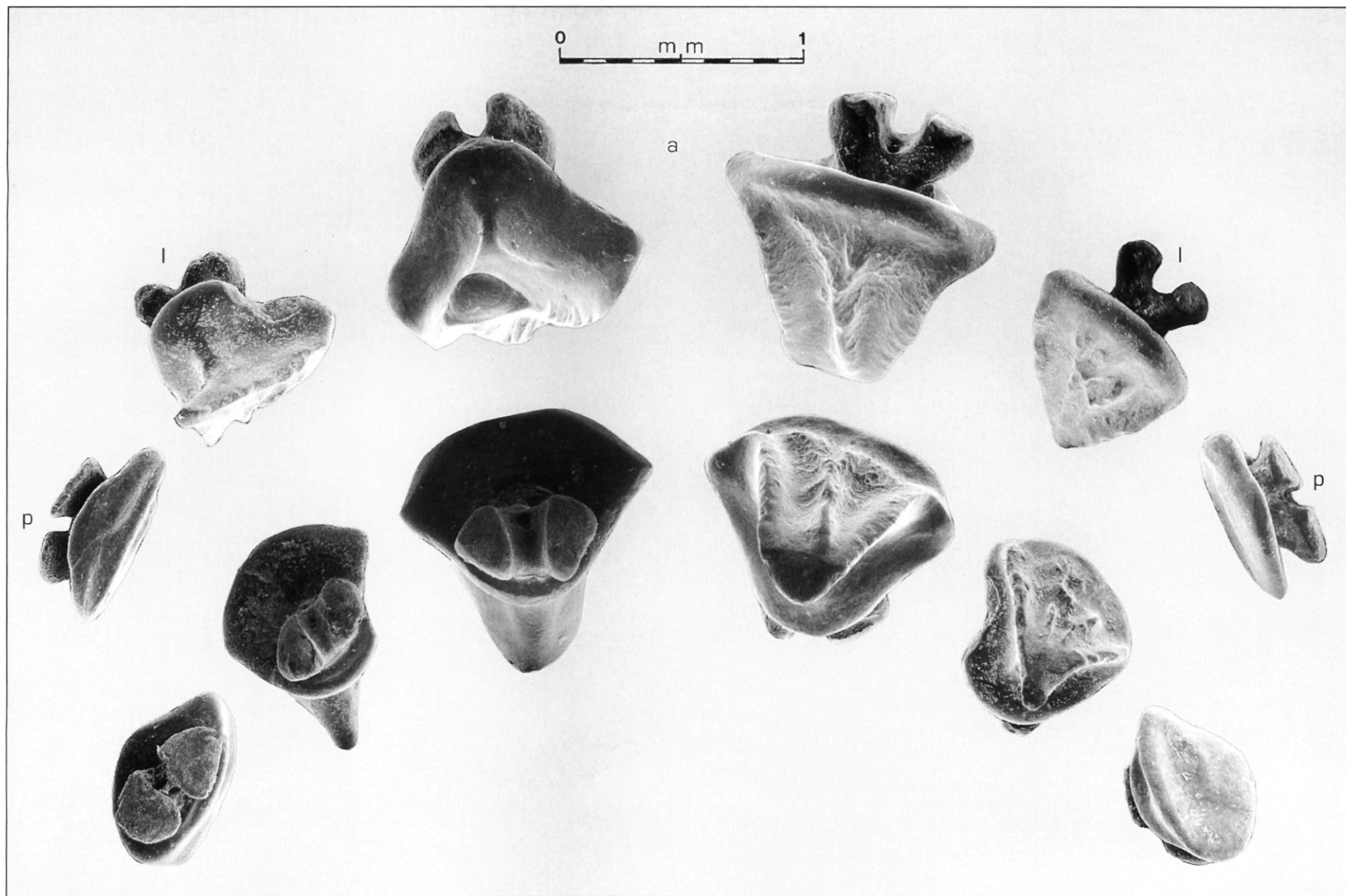


Plate 4. — *Taeniura lymma* (FORSKAL, 1775). Male 57 cm t.l., off Madagascar. Upper teeth.

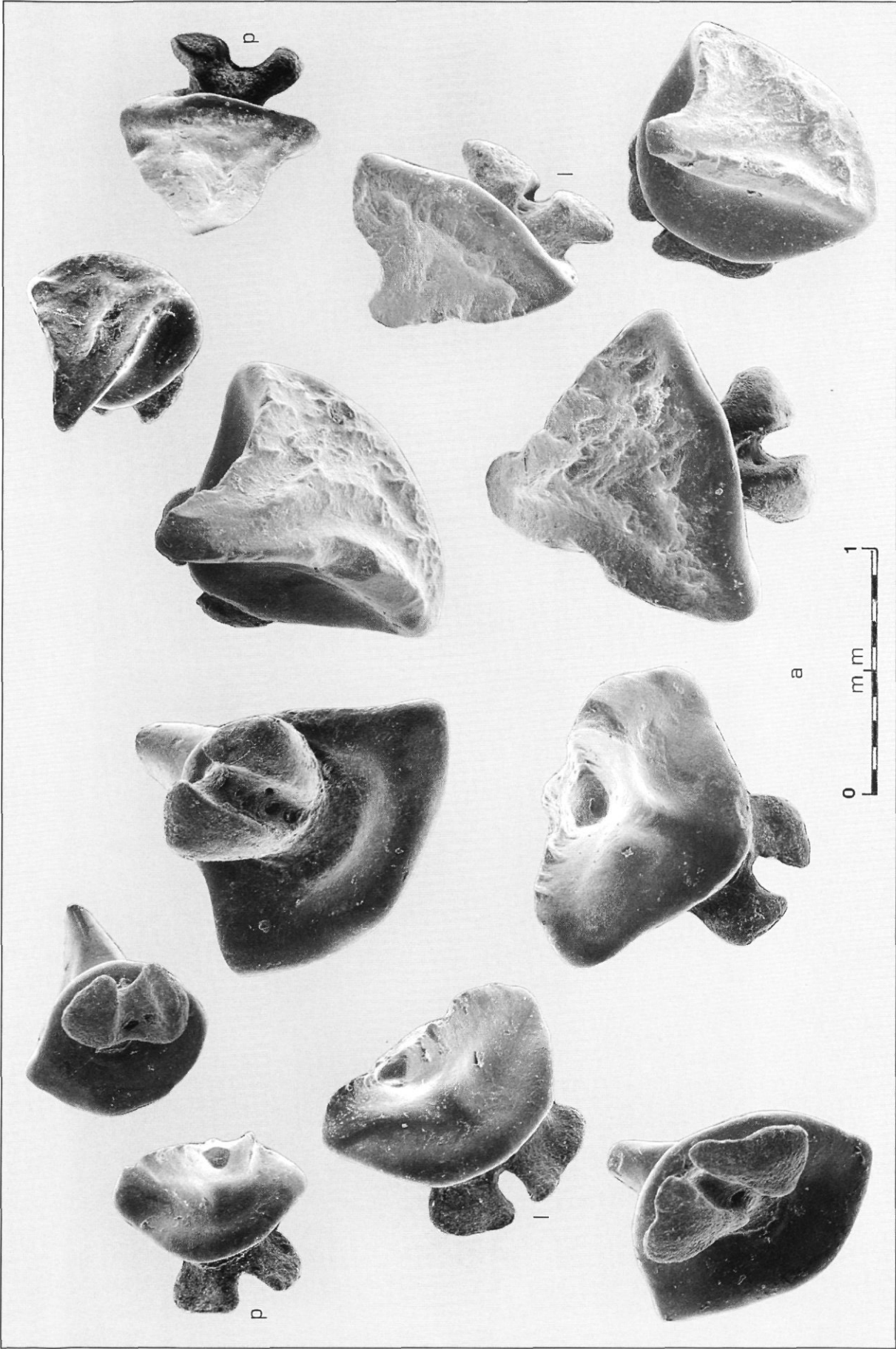


Plate 5. - *Taeniura lymma* (FORSKAL, 1775). Male 57 cm t.l., off Madagascar. Lower teeth.

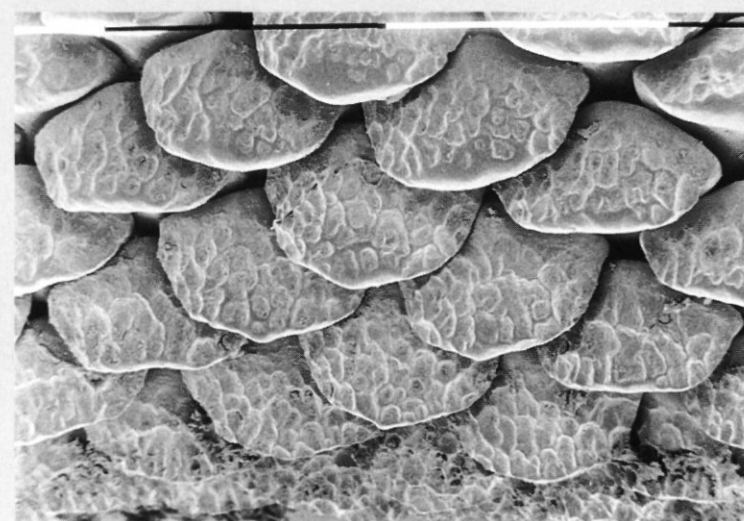
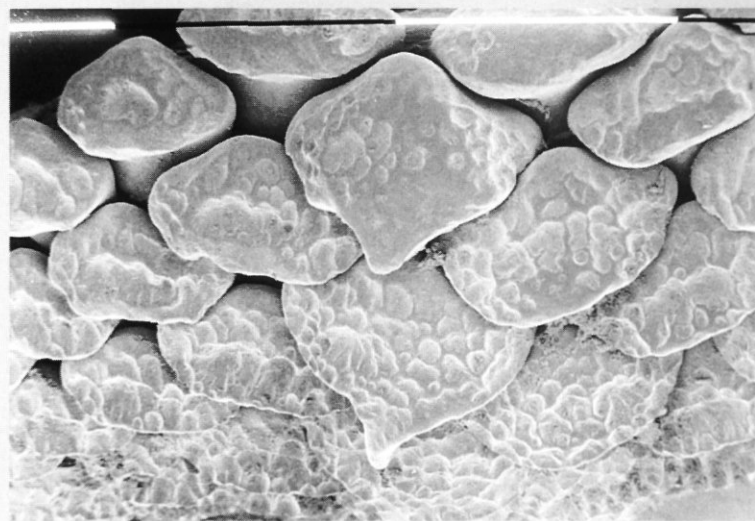
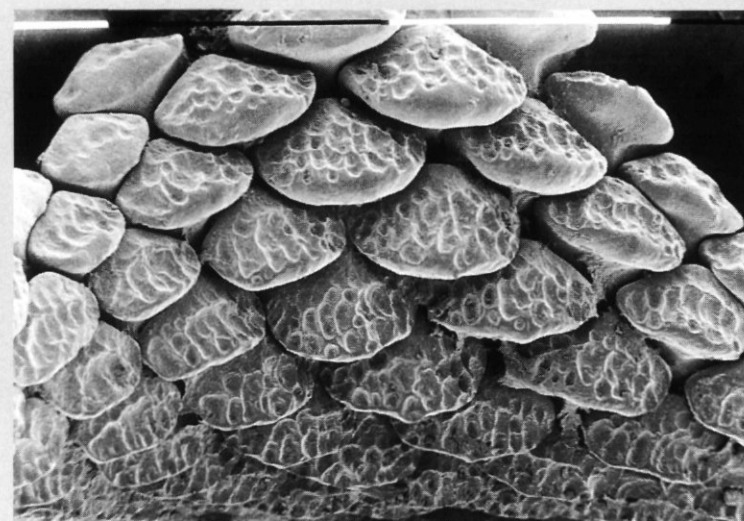
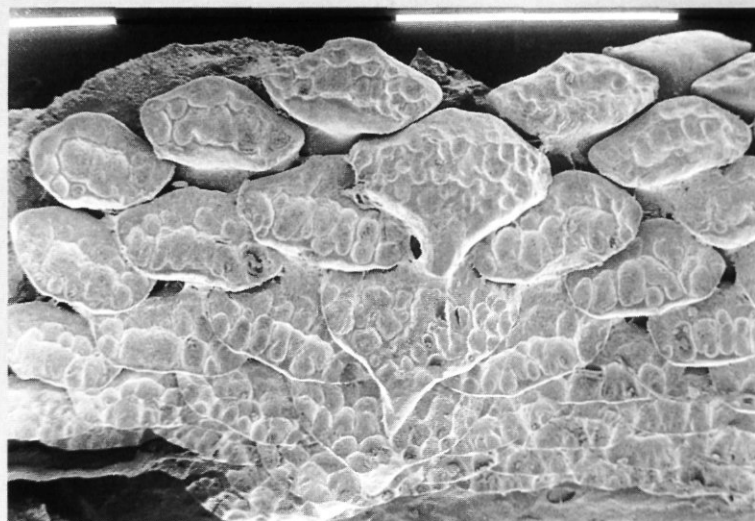


Plate 6. – *Taeniura lymma* (FORSKAL, 1775). Details of upper symphyseal and lateral parts of dentition of a male 36 cm t.l. (above) and a female 26.5 cm t.l.(below), Indian Ocean. Milimetric scale bars.

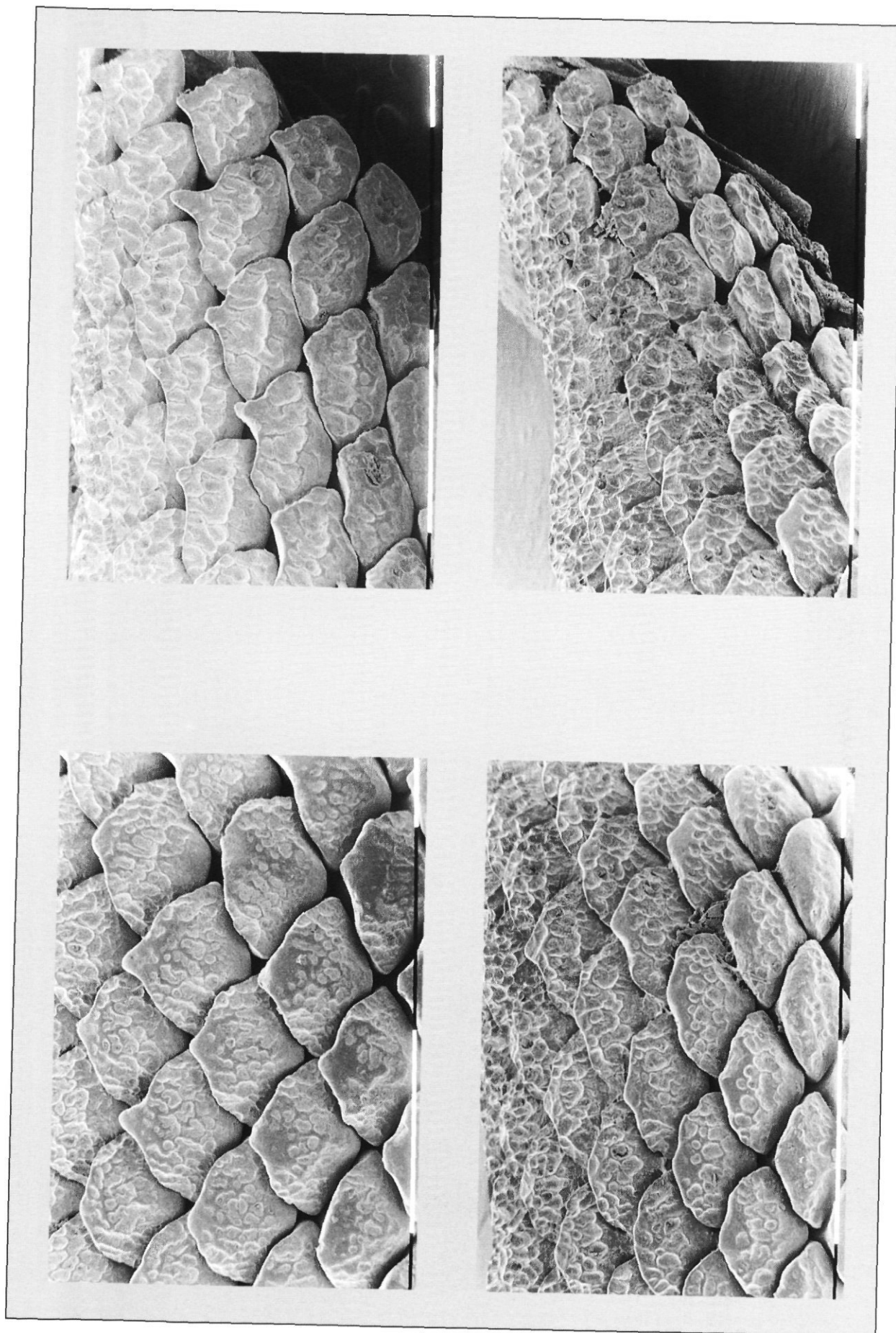


Plate 7. - *Taeniura lymma* (FORSKAL, 1775). Details of lower symphyseal and lateral parts of dentition of a male 36 cm t.l. (above) and a female 26.5 cm t.l. (below), Indian Ocean. Millimetric scale bars.



Plate 8. — *Disceus thayeri* GARMAN, 1913. Male 52 cm t.l., Rio Branco, Brasil. Upper teeth.



Plate 9. – *Discus thayeri* GARMAN, 1913. Male 52 cm t.l., Rio Branco, Brasil. Lower teeth.

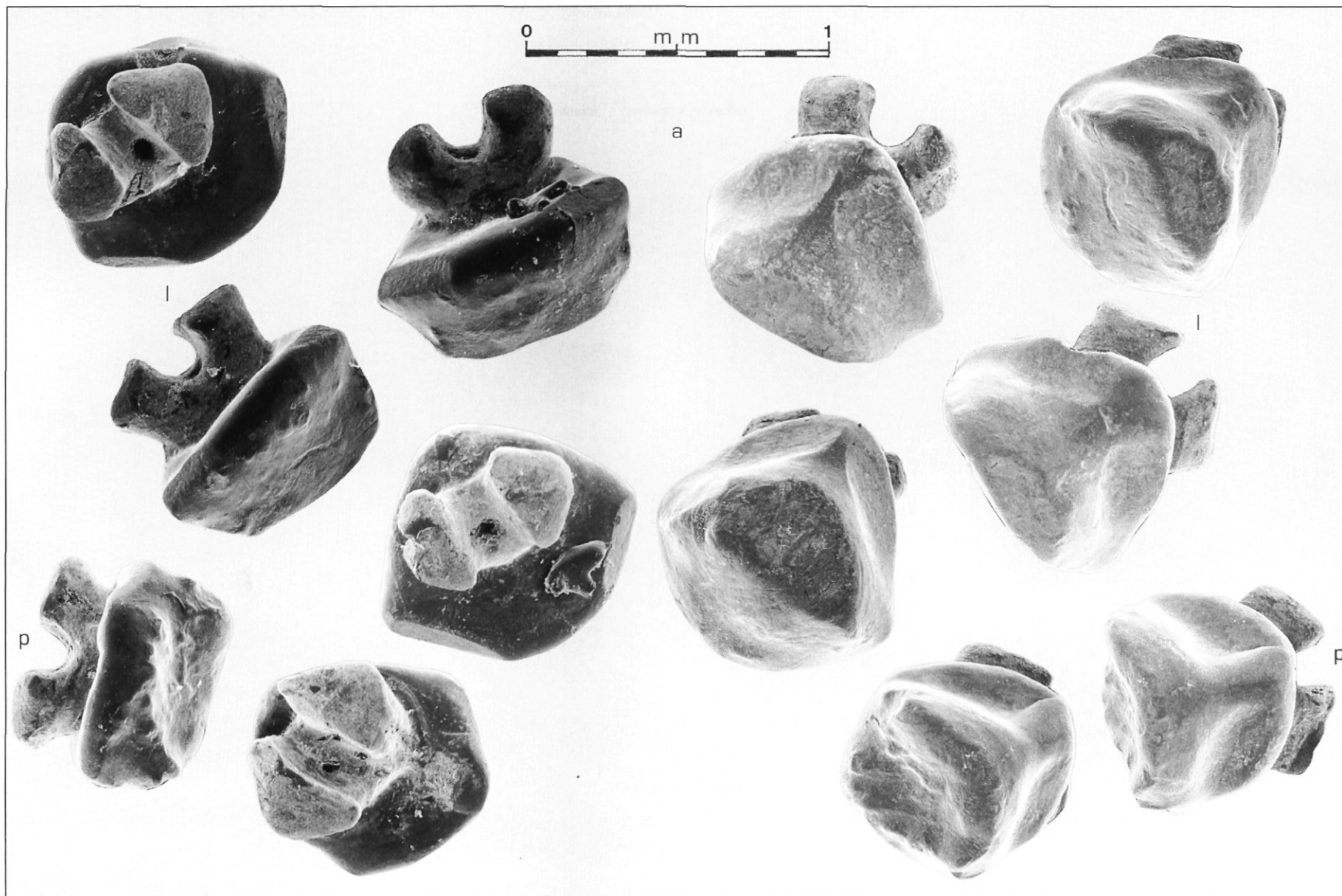


Plate 10. – *Plesiotrygon iwamae* ROSA, CASTELLO & THORSON, 1987. Male 126 cm t.l., 34 cm d.w., Rio Sonora, Brasil. Upper teeth.

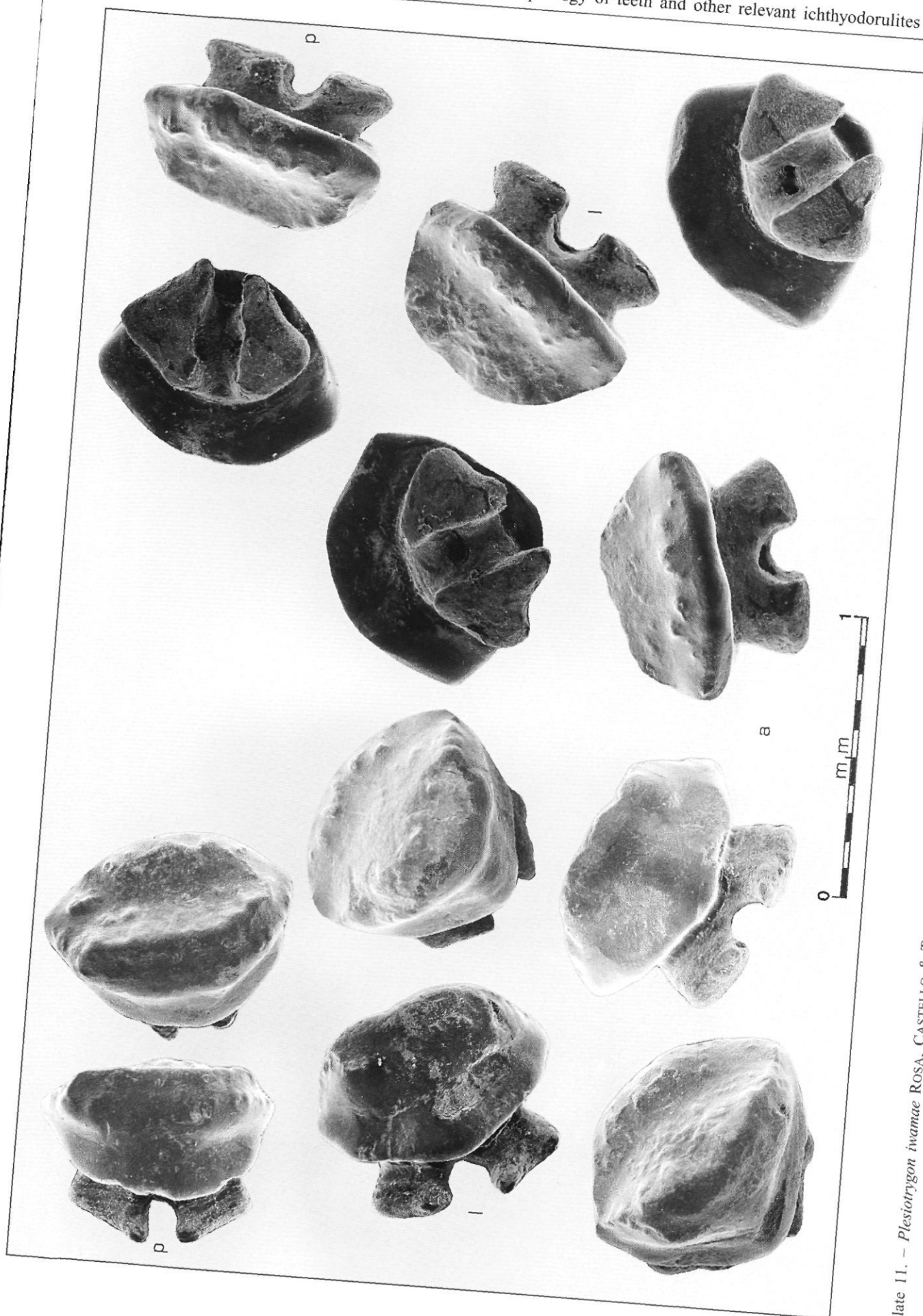


Plate 11. – *Plesiотrygon iwamae* ROSA, CASTELLO & THORSON, 1987. Male 126 cm t.l., 34 cm d.w., Rio Sonora, Brasil. Lower teeth.



Plate 12. – *Plesiotrygon iwamae* ROSA, CASTELLO & THORSON, 1987. Paratype, male 96 cm t.l., 28 cm d.w., Rio Amazonas, Brasil. Upper teeth.



Plate 13. – *Plesiotrygon iwamae* ROSA, CASTELLO & THORSON, 1987. Paratype, male 96 cm t.l., 28 cm d.w., Rio Amazonas, Brasil. Lower teeth.

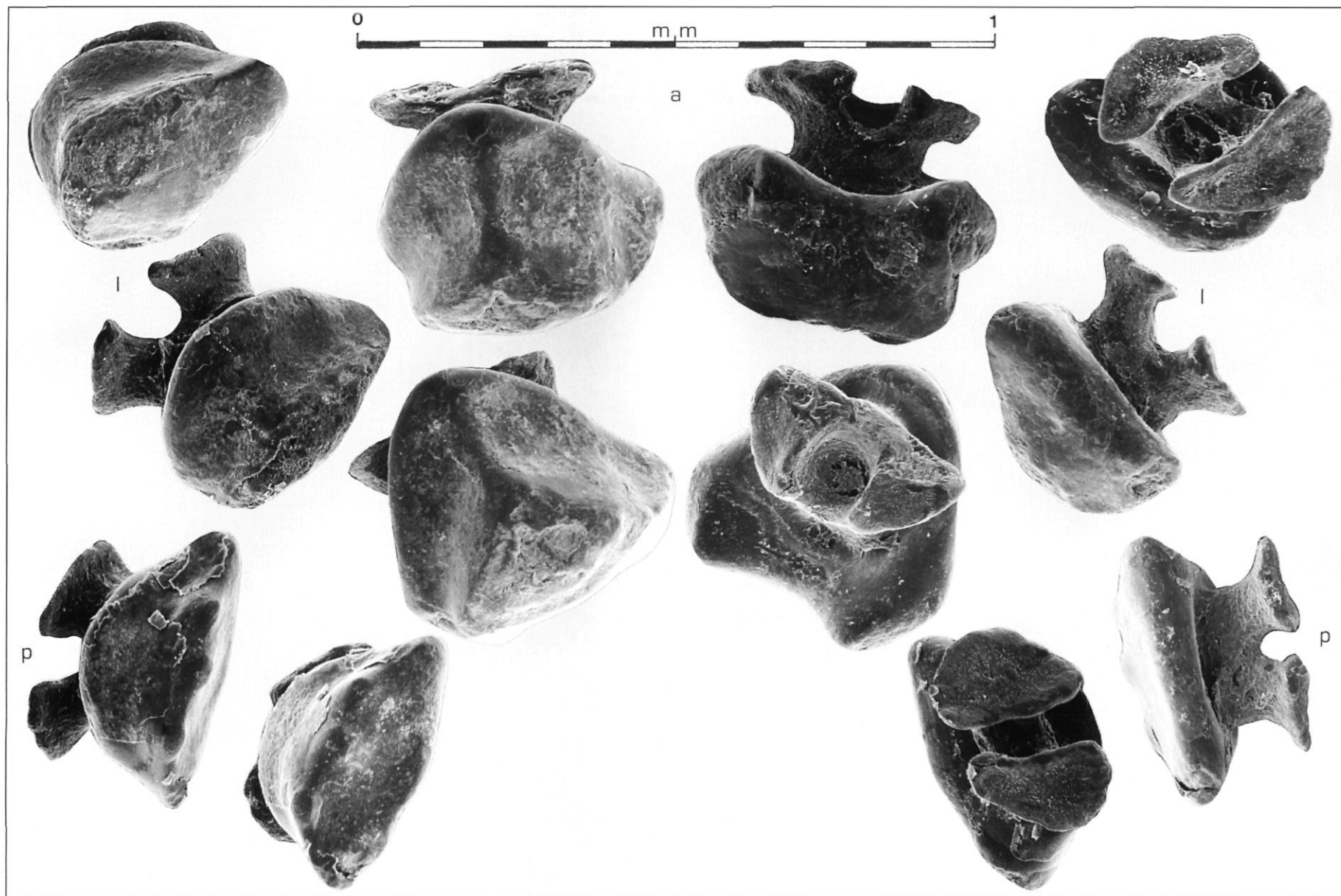


Plate 14. – *Potamotrygon histrix* (MULLER & HENLE, 1841). Male 31 cm t.l., British Guyana. Upper teeth.



Plate 15. — *Potamotrygon histrix* (MULLER & HENLE, 1841). Male 31 cm t.l., British Guyana. Lower teeth.

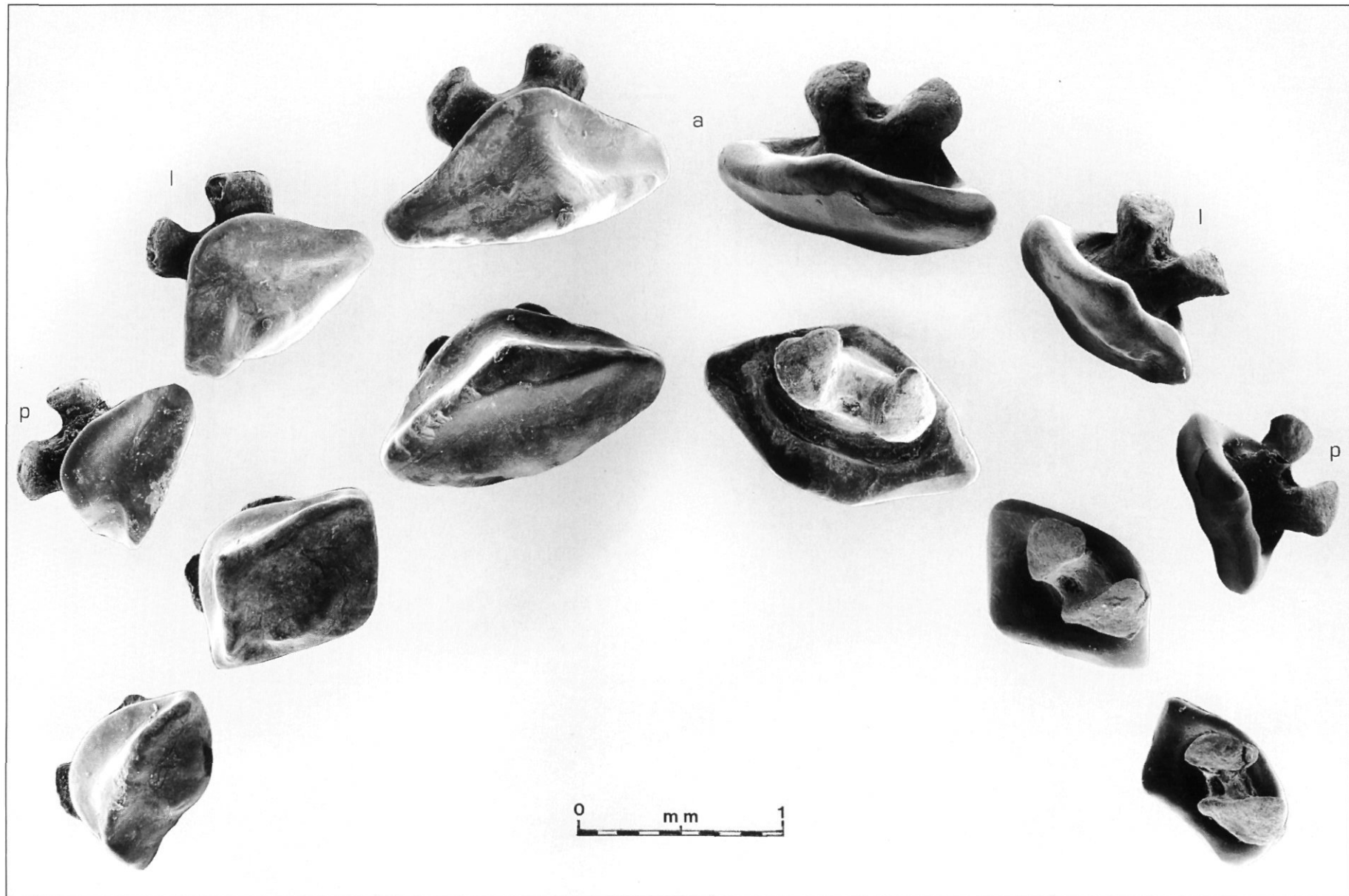


Plate 16. – *Trygonoptera testacea* (GUNTHER, 1870). Male 50 cm t.l., 20.5 cm d.w., Botany Bay, Australia. Upper teeth.

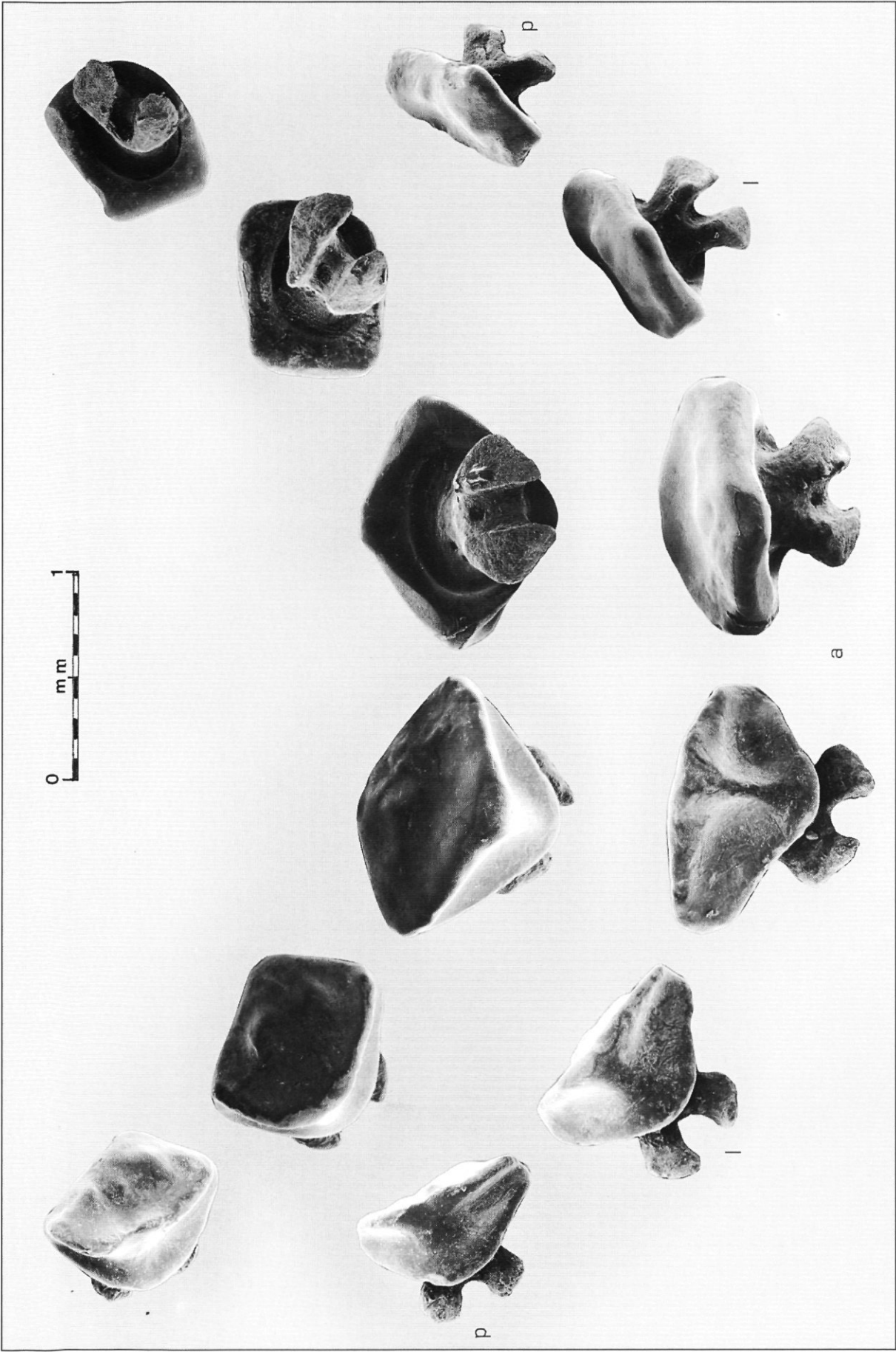


Plate 17. – *Trygonoptera testacea* (GUNTHER, 1870). Male 50 cm t.l., 20.5 cm d.w., Botany Bay, Australia. Lower teeth.

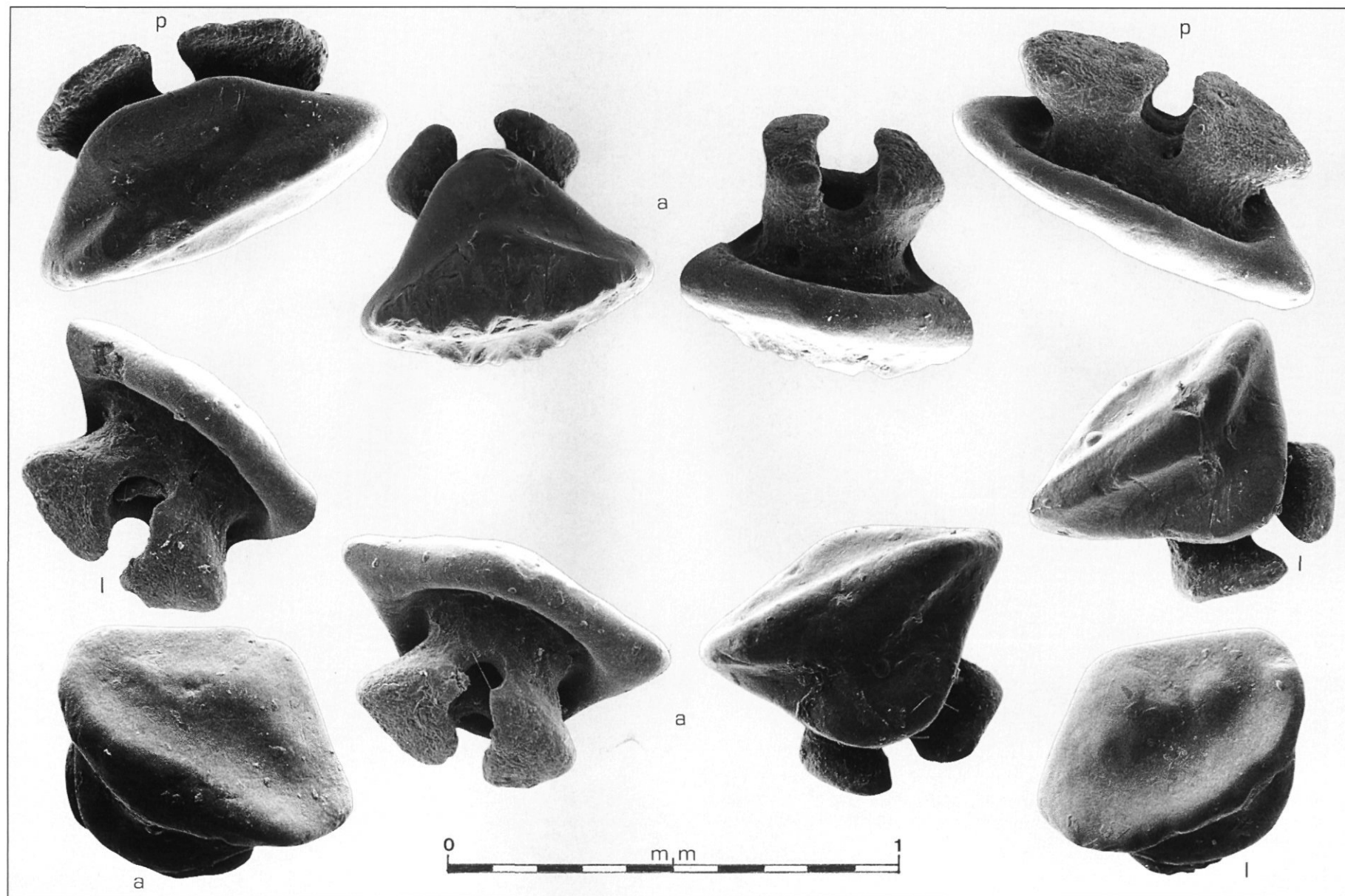


Plate 18. – *Trygonoptera testacea* (GUNTHER, 1870). Female 32 cm t.l., Port Jackson, Australia. Upper and lower teeth.

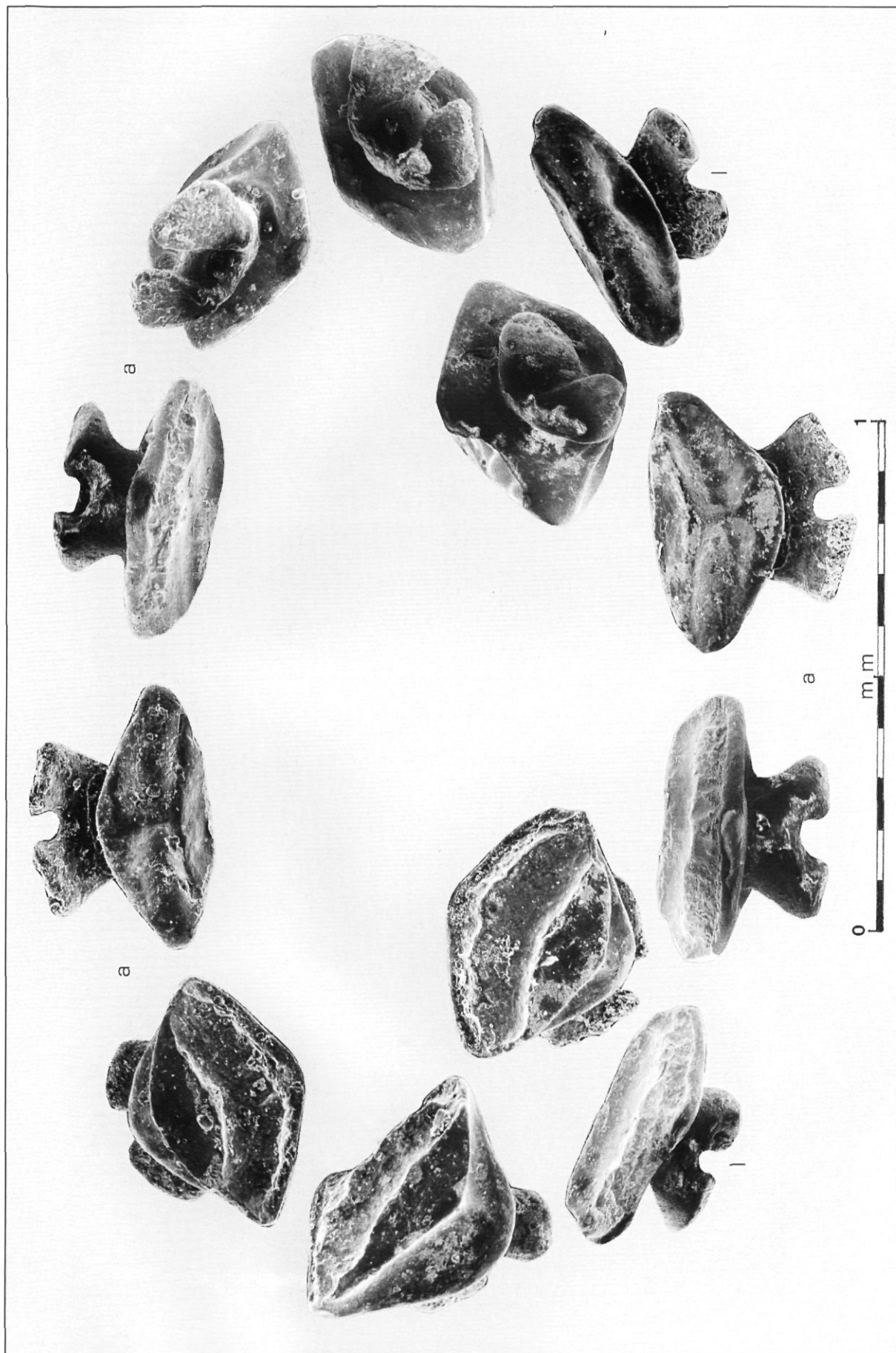


Plate 19. – *Urolophus cruciatus* (LACEPEDE, 1804). Male 21 cm t.l., Port Royal, S.W. Australia. Upper and lower teeth.

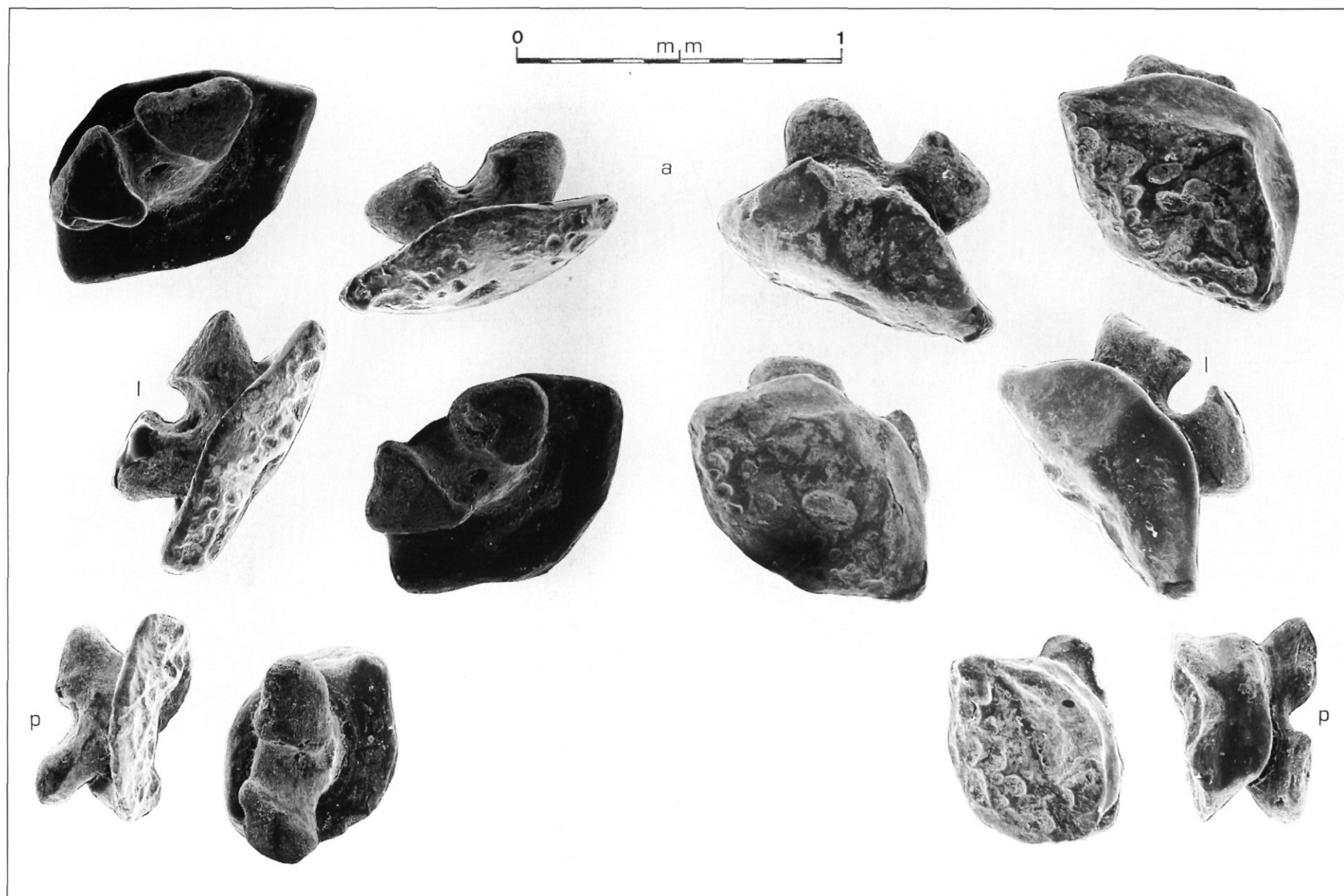


Plate 20. — *Urolophus cruciatus* (LACEPEDE, 1804). Female 38 cm t.l., Port Royal, S.W. Australia. Upper teeth.

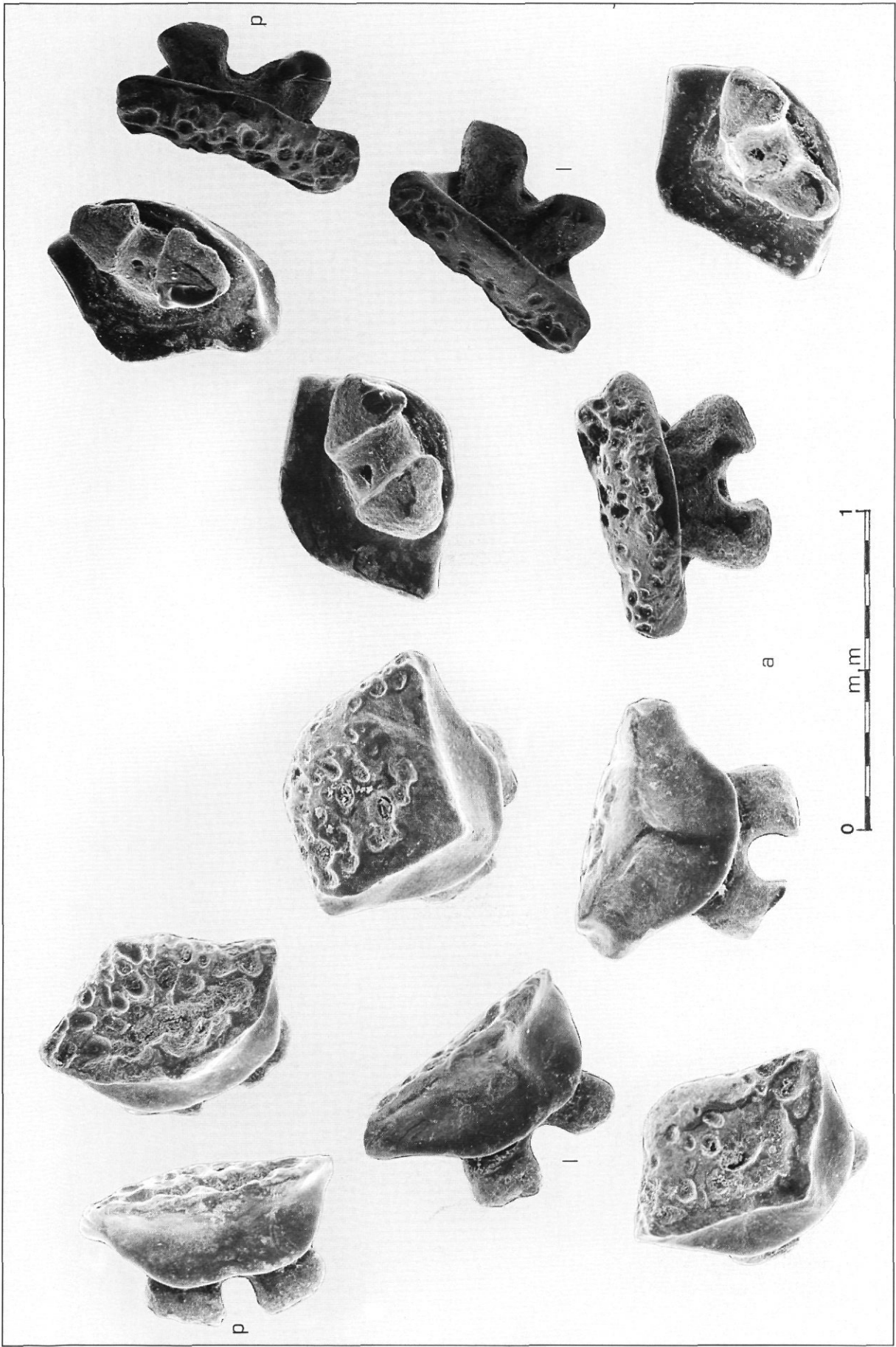


Plate 21. - *Urolophus cruciatus* (LACEPEDE, 1804). Female 38 cm t.l., Port Royal, S.W. Australia. Lower teeth.

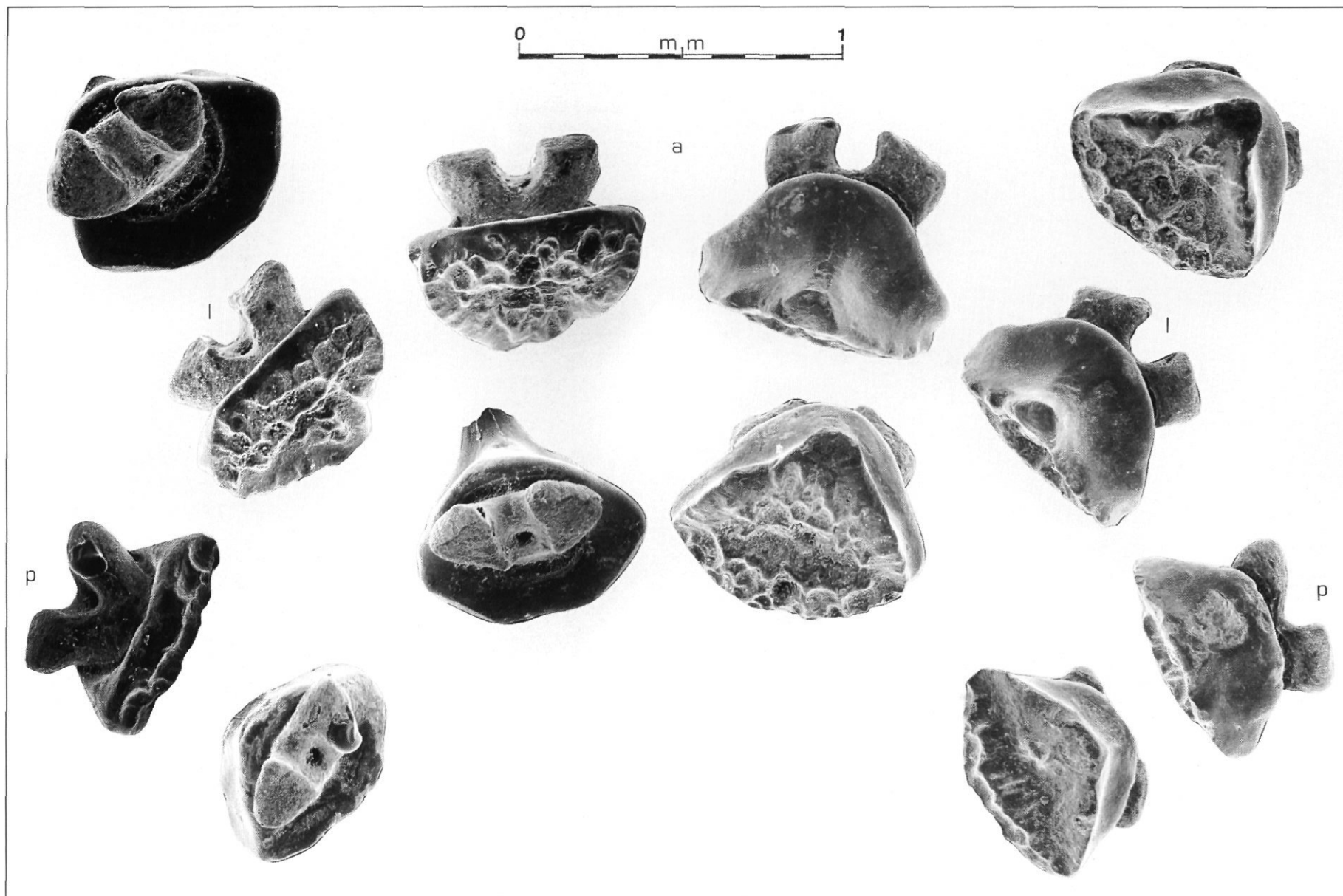


Plate 22. — *Urolophus cruciatus* (LACEPEDE, 1804). Male 33 cm t.l., Port Royal, S.W. Mexico. Upper teeth.

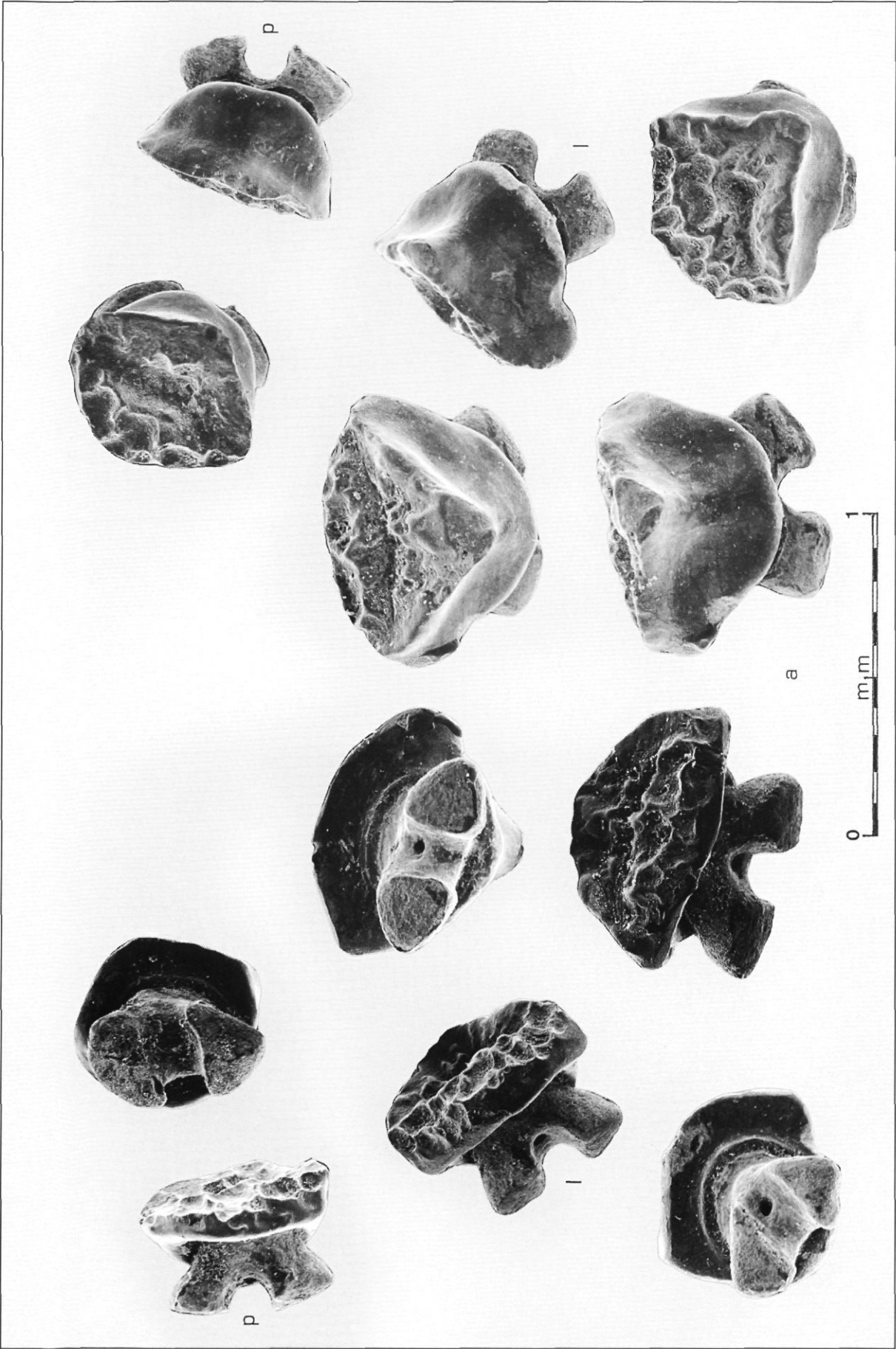


Plate 23. — *Urolophus cruciatus* (LACEPEDE, 1804). Male 33 cm t.l., Mazatlan, Mexico. Lower teeth.



Plate 24. — *Urotrygon mundus* GILL, 1863. Female 24 cm t.l., Pacific coast, Costa Rica. Upper teeth.

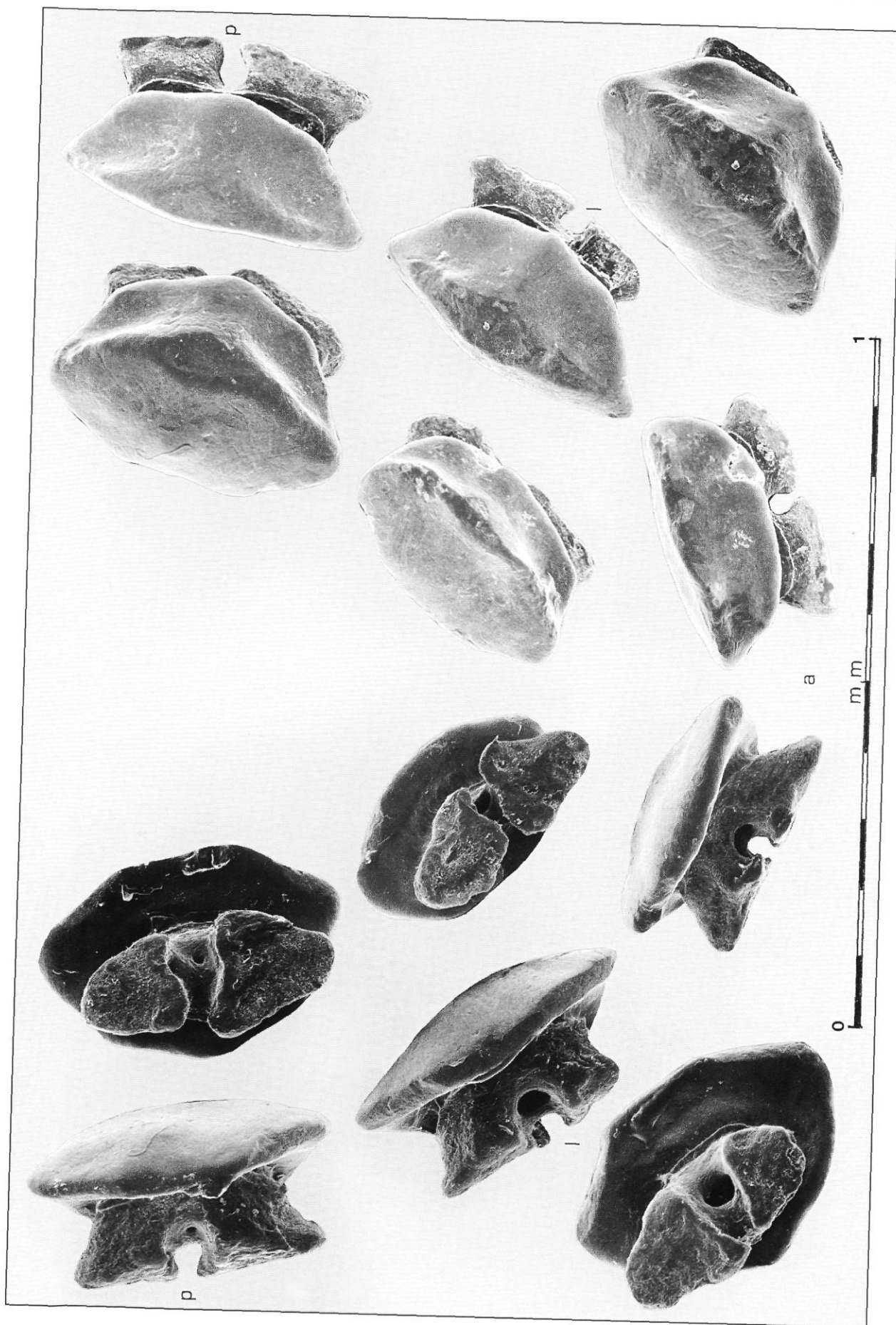


Plate 25. - *Urotrygon mundus* GILL, 1863. Female 24 cm t.l., Pacific coast, Costa Rica. Lower teeth.

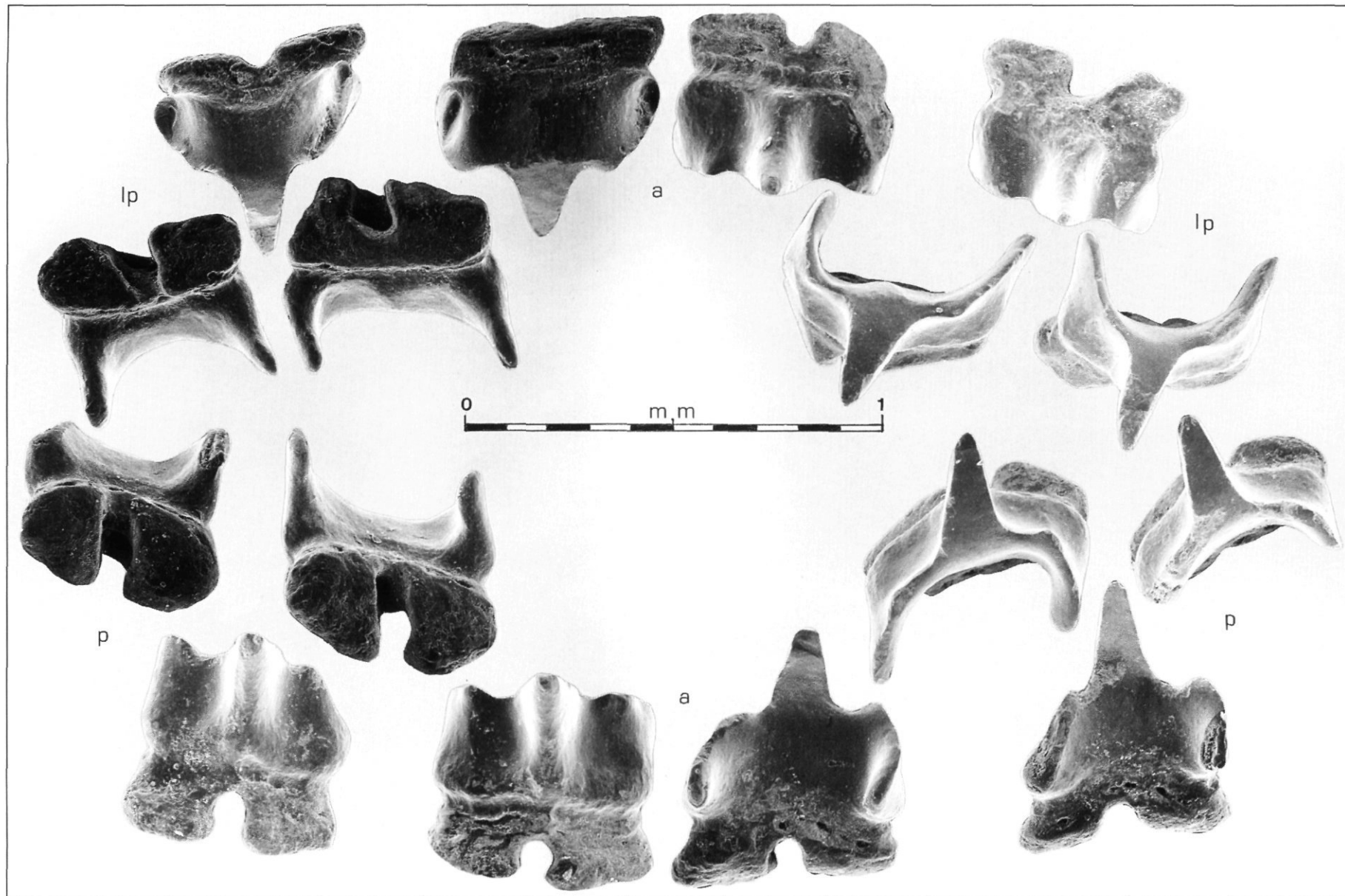


Plate 26. – *Aetoplatea tentaculata* VALENCIENNES, 1839. Female 46 cm t.l., 61 cm d.w., mouth Hughli River, India. Upper and lower teeth.

